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D1.1 – Regulation, Certification and Standard Review Report

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Executive Summary

The primary focus of this deliverable was to provide in depth research into regulations, certifications and standards that affect on-site wastewater treatment and sewage derived water re-use options for various regions around the world. Partners with relevant expertise in this field undertook structured research for their relevant regions. This report includes a review of Continental, National and Regional regulations and standards concerning the application of the selected technologies and the potential for re-using water derived from such systems. The following regions were assessed:

- Africa (Tanzania)
- Eastern Europe (Romania)
- Western Europe (UK, Scotland, Ireland, France, Spain, Italy)
- Latin America (Peru & Ecuador)
- Others (India & Turkey)

This piece of research assessed environmental, economic and health considerations associated with the application of the INNOQUA technologies in order to identify the relevant legislation.

The relevant regulations, certifications and standards that must be considered were successfully investigated for each region.

The findings from this report highlighted the differences that exist between the applied regulations according to the specific continent, country, region and locality in which wastewater treatment/reuse is applied. It also investigated other important considerations that will need to be taken into consideration if the INNOQUA technologies are to be successfully applied in these regions.

These findings will provide vital information for subsequent tasks related to the design and prototyping of the technologies and ensure that the technologies are strongly market focused.

1 Introduction

The aim of the INNOQUA project is to develop a strongly market focused modular set of innovative, scalable, fully ecological sanitation solutions for rural communities worldwide. The types of technologies selected and their proposed application provides a novel approach to on-site sanitation with the potential for zero waste production and the opportunity to produce re-usable water.

Work Package 1 (WP1) in the INNOQUA project is associated with identifying pre-commercialisation challenges that may be faced by such innovative solutions. This will allow the involved parties to quantify and prioritise target markets based upon market potential and end-user requirements. These are likely to be region and location specific. For this reason, partners with experience in this field from various locations around the globe will contribute to a global market research study.

Deliverable 1.1 (D1.1) provides the market research that is imperative to ensuring that the technologies are strongly market focused. This encompasses in depth research into associated regulations, certifications and standards for each region.

This is one of the first steps in realising the challenges that may be faced by commercialisation of the INNOQUA technologies in the proposed pilot locations and will form the basis of the pre-market research to identify where and how the selected technologies are best marketed. It will also identify the requirements that will directly affect the development, design and implementation of the trialled sustainable, eco-innovative, biological wastewater treatment solutions. This will help to minimise time, risk and costs associated with the project by providing key information for the design and prototyping of the technologies that will feed into Work Packages 2, 3, 4 and 5.

As part of this research assignment an assessment of national and international regulations, guidelines, certifications and standards associated with on-site sanitation and potential water re-use markets was undertaken. In undertaking this research it is important to consider the specific configurations and constraints of the different technologies while being mindful of economic, environmental and health considerations. This will aid in the development of an optimised market entry strategy for the selected technologies.

Research was conducted for the following regions:

- Africa (Tanzania)
- Eastern Europe (Romania)
- Western Europe (UK, Scotland, Ireland, France, Spain, Italy)
- Latin America (Peru & Ecuador)
- Others (India & Turkey)

There may be a potential market for the application of the INNOQUA technologies in each of these regions. INNOQUA partners with the most knowledge and experience in each region were selected to conduct this piece of research.

2 Worldwide Common Regulation, Certification and Standards

This report assess the recommendations and legislation associated with protecting human health and the environment from exposure to and re-use of treated and un-treated wastewater. A detailed assessment of the applied legislation relevant to the INNOQUA technologies will be undertaken.

There are various regulations and certifications that govern safe practices associated with wastewater treatment and re-use, however considerable differences exist between the applied regulations according to the specific continent, country, region and locality in which wastewater treatment/reuse is applied. Later in this report we will look into the specific regulations associated with various regions around the world, with a particular focus on the selected locations of the pilot sites for the INNOQUA project. These include Tanzania (Africa), Romania (Eastern Europe), Italy, France, Spain, United Kingdom (Western Europe), Peru, Ecuador (Latin America), India and Turkey. This section of the report will review the broader picture of health and environmental implications associated with these practices and what recommendations and regulations are in place on a worldwide scale for the protection of human health and the environment.

The INNOQUA project team have selected four wastewater treatment technologies for further trials. These include the Lumbrifilter, Daphniafilter, Bio-Solar Purification (BSP) and UV lamp technologies. The purpose of this project is to identify the achievable effluent quality through each of the selected wastewater treatment processes and identify the regions and markets that could benefit from utilising these technologies to treat wastewater and obtain safe re-usable water (for specified purposes). The technologies to be piloted have been selected because they are considered to be potentially less energy demanding, low cost, do not require chemical addition and provide more sustainable treatment solutions to conventional alternatives, while providing sufficient (or better) levels of wastewater treatment.

Wastewater treatment and re-use poses significant risk to the environment. Discharge of untreated or poorly treated wastewater can contaminate water, soil and air. Water pollution can affect the entire biosphere including plants and organisms living in these bodies of water. In many cases the effect is damaging not only to individual species and populations, but also to natural biological communities. For example, soil contamination can be caused by chemical content of wastewater; among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons depending on the source of the wastewater. Air pollution caused by wastewater is mainly associated with unpleasant odour and volatile organic compounds such as methane. Environmental protection regulations intend to protect the quality of air, water and soil by controlling emission, pollution and contamination. Many countries have organisations and agencies devoted to environmental protection, while there are also some international environmental protection organisations, such as the United Nations Environment Programme.

The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system and serves as an authoritative advocate for the global environment[1].

Provided that it is implemented safely, irrigation of agricultural land with wastewater can conserve natural resources through increasing the available water supply and/or ensuring better quality waters for alternative uses. In addition to the direct economic benefits associated with these practices, due to the nutrient content (primarily N, and P) of wastewater, this also retains a high value as a fertiliser.[1] The use of wastewater for irrigation does however present some health risks. These can be split into two types of hazard, the health and safety of those working on or living within close proximity of the wastewater irrigated land, and the hazards associated with consumption of crops, or consumption of animals that have been infected e.g. through grazing on the irrigated land. Diseases spread by such routes of exposure can be fatal and are usually associated with exposure to pathogenic organisms that include bacteria, viruses, protozoa and helminths.[1] For these reasons, in many countries, legislation is enforced to control the quality of water that can be utilised for discharge to the environment and also for irrigation purposes. However, due to a lack of direct epidemiological data on the relationship between irrigation water quality and disease transmission or infection, there are currently no enforceable international standards for the microbial quality of water used for crop irrigation.[2]

The world health organisation (WHO) are recognised for their work with governments around the world to coordinate international health within the United Nations system. A large part of the research they undertake is aimed at setting targets and guidelines for improved sanitation standards for the protection of human health, with a particular focus on developing countries. With respect to the INNOQUA project, it will be important to ensure that the selected technologies provide suitable treatment so that produced effluents are compliant with WHO water quality guidelines. These guidelines are split into three key areas, based upon the purpose of the produced water; drinking water, wastewater/excreta reuse and recreational waters. A preventative, risk-based approach is applied to minimise water-related infectious diseases.

The guidelines are implemented through the development of water safety plans (WSPs) and sanitation safety plans (SSPs).[2] A summary of these plans is provided in Table 1. Water usage has been split into three categories, drinking water, wastewater & excreta reuse and recreational waters. For each, the relevant guidelines and practical frameworks are outlined.

[1] *http://www.unep.org/about/*
[2] *FAO, Health risks associated with wastewater use – Chapter 2 [www.fao.org/docrep/w5367e/w5367e04.htm]*

Table 1: WHO Guidelines for the use of Wastewater[3]

	Drinking Water	**Wastewater & Excreta Reuse**	**Recreational Waters**
Guidelines	Drinking Water Quality	Safe use of wastewater, excreta and greywater, 2006	Safe Recreational Water Environments, 2003
Framework	Water Safety Plan (WSP) Manual, 2009 WSP for small community supplies, 2012 WSP, 2014	Sanitation safety Plan (SSP) SSP Manual: safe use and disposal of wastewater, greywater and excreta, 2015	

These guidelines and safety plans are designed to protect public health through preventing the transmission of disease while maximising the health, environmental and economic benefits associated with the use of wastewater, excreta and greywater in agriculture and aquaculture. All of the health protection measures stated in the guidelines and safety plans are targeted at large population groups and in some instances are focussed on specific vulnerable groups[4]. For various nations around the world, the guidelines set by the WHO are often utilised to support the implementation of national standards and regulations. However, there can be some variation from one nation to the next due to country specific health, environment, economic and social priorities and conditions.

The primary health hazards associated with the use of wastewater, excreta and greywater in agriculture and aquaculture are excreta-related pathogens, some vector-borne diseases and certain chemicals[2]. Some pathogens can survive within the environment for sufficient periods to be passed on to people at a later time.

Some natural conditions within the environment can affect the pathogen kill rate and hence the likelihood and/or severity of detrimental health impacts[5], these include:

- Time
- Temperature
- Moisture
- UV radiation exposure
- Presence of intermediate hosts
- Type of plant/crop exposed to

[3] WHO 2016, Water safety management in the WHO water quality guidelines (Quantitative Microbial Risk Assessment

[4] WHO, 2006, Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Volume 1 Policy and Regulatory Aspects

[5] WHO 2016, Water safety management in the WHO water quality guidelines (Quantitative Microbial Risk Assessment

The majority of health risks associated with wastewater reuse relate to the consumption of pathogenic bacteria.

Details of the health risks associated with exposure to wastewater and those most at risk are summarised in Table 2.

Table 2: Summary of health risks attributed to exposure to wastewaters[6]

Group exposed	Health threats		
	Nematode infection	**Bacteria/viruses**	**Protozoa**
Consumers	Significant risk of *Ascaris* infection for both adults and children with untreated wastewater	Cholera, typhoid and shigellosis outbreaks reported from use of untreated wastewater; seropositive responses for *Helicobacter pylori* (untreated); increase in non-specific diarrhoea when water quality exceeds 10^4 thermotolerant coliforms/100 ml	Evidence of parasitic protozoa found on wastewater-irrigated vegetable surfaces, but no direct evidence of disease transmission
Farm workers and their families	Significant risk of *Ascaris* infection for both adults and children in contact with untreated wastewater; risk remains, especially for children, when wastewater treated to <1 nematode egg per litre; increased risk of hookworm infection in workers	Increased risk of diarrhoeal disease in young children with wastewater contact if water quality exceeds 10^4 thermotolerant coliforms/100 ml; elevated risk of *Salmonella* infection in children exposed to untreated wastewater; elevated seroresponse to norovirus in adults exposed to partially treated wastewater	Risk of *Giardia intestinalis* infection was insignificant for contact with both untreated and treated wastewater; increased risk of amoebiasis observed with contact with untreated wastewater
Nearby communities	*Ascaris* transmission not studied for sprinkler irrigation, but same as above for flood or furrow irrigation with heavy contact	Sprinkler irrigation with poor water quality (10^6–10^8 total coliforms/100 ml) and high aerosol exposure associated with increased rates of infection; use of partially treated water (10^4–10^5 thermotolerant coliforms/100 ml or less) in sprinkler irrigation is not associated with increased viral infection rates	No data on transmission of protozoan infections during sprinkler irrigation with wastewater

As a result, pathogen control should be implemented as a priority, with the minimum level of pathogen removal required dependent upon the proposed use of the wastewater.

Table 3 shows how pathogen reductions can be achieved via various means.

[6] *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Volume 1 Policy and Regulatory Aspects, WHO, 2006*

Table 3: Pathogen Reduction Measures; WHO[7]

Control measure	Pathogen reduction (log units)	Notes
Excreta storage without fresh additions	6	The required pathogen reduction to be achieved by excreta treatment refers to stated storage times without addition of fresh untreated excreta. Pathogen reductions for different treatment options are presented in chapter 5 of Volume 4.
Greywater treatment	1–>4	Values relate to the relevant treatment options. Generally, the highest exposure reduction is related to subsurface irrigation.
Localized (drip) irrigation with urine (high-growing crops)	2–4	Crops where the harvested parts have not been in contact with the soil
Materials directly worked into the soil	1	Should be done at the time when faeces or urine is applied as a fertilizer
Pathogen die-off (withholding time one month)	4–>6	A die-off of 0.5–2 log units per day is cited for wastewater irrigation. Reduction values cited are conservative to account for a slower die-off of a fraction of the remaining organisms.
Produce washing with water	1	Washing salad crops, vegetables and fruit with clean water
Produce disinfection	2	Washing salad crops, vegetables and fruit with a weak disinfectant solution and rinsing with clean water
Produce peeling	2	Fruits, root crops
Produce cooking	6–7	Immersion in boiling or close-to-boiling water until the food is cooked ensures pathogen destruction

Sources: Beuchat (1998); Petterson & Ashbolt (2003); NRMMC & EPHCA (2005).

There are some practices that can be undertaken by the consumer to reduce pathogen numbers in crops prior to consumption including washing, disinfecting, peeling and cooking. However, the health risks associated with wastewater usage can be substantially reduced by collection and treatment prior to use for irrigation of crops.

The most basic of on-site treatment methods simply relies upon collection and sufficient storage times to achieve adequate pathogen kill. In order to consistently achieve better quality and safer waters, more intensive treatment processes are often required. These typically use mechanical/physical, biological and chemical processes that contribute to the removal of pollutants such as suspended solids (SS), substances that derive a biochemical oxygen demand (BOD), nutrients and other chemical pollutants. Some wastewater treatment processes can be utilised to remove pathogens from wastewaters such that these can be safely reused for irrigation and other purposes, however these can be expensive to install, commission and operate, with often high energy and labour demands.

Table 4 highlights typical pathogen removal through various wastewater treatment process.

[7] *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Volume 1 Policy and Regulatory Aspects, WHO, 2006*

Table 4: Typical Concentration of E-Coli and Faecal Streptococci in raw and treated sewage (Gross and Cook, 1995)[8]

Treatment Stage	**E. coli 100 ml $^{-1}$**	**Faecal Streptococci 100 ml $^{-1}$**
Raw Sewage	$1x10^7$	$1x10^6$
Stormwater	$1x10^5$	$1x10^4$
Primary Treated Sewage	$5x10^6$	$5x10^5$
Secondary Treated Sewage	$1x10^6$	$1x10^5$
UV Disinfected Final Effluent (assuming 99.9% kill)	$5x10^2$	$5x10^1$

Following conventional wastewater treatment, including primary settlement and secondary biological treatment processes, E-Coli and Faecal Streptococci numbers are typically still relatively high at $1x10^6$ and $1x10^5$ respectively.

The WHO have outlined a series of recommended E.Coli and Faecal streptococci concentrations in wastewaters used for irrigation in agriculture (Table 5).

[8] *Biology of Wastewater Treatment, N.F. Gray, Imperial College Press, 2004*

Table 5: Guidelines for microbiological concentrations in treated wastewater for use in agriculture[9]

Category	Reuse conditions	Exposed group	Irrigation technique	Intestinal nematodes[b] (arithmetic mean no. of eggs per litre[c])	Faecal coliforms (geometric mean no. per 100 ml[d])	Wastewater treatment expected to achieve required microbiological quality
A	Unrestricted irrigation					Well-designed series of waste stabilization ponds (WSP), sequential batch-fed wastewater storage and treatment reservoirs (WSTR) or equivalent treatment (e.g., conventional secondary treatment supplemented by either polishing ponds or filtration and disinfection)
	A1 For vegetable and salad crops eaten uncooked, sports fields, public parks[e]	Workers, consumers, public	Any	$\leqslant 0.1$[f]	$\leqslant 10^3$	
B	Restricted irrigation					
	Cereal crops, industrial crops, fodder crops, pasture and trees[g]	B1 Workers (but no children <15 years), nearby communities	Spray or sprinkler	$\leqslant 1$	$\leqslant 10^5$	Retention in WSP series including one maturation pond or in sequential WSTR or equivalent treatment (e.g., conventional secondary treatment supplemented by either polishing ponds or filtration)
		B2 as B1	Flood/furrow	$\leqslant 1$	$\leqslant 10^3$	As for Category A
		B3 Workers including children <15 years, nearby communities	Any	$\leqslant 0.1$	$\leqslant 10^3$	As for Category A
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Trickle, drip or bubbler	Not applicable	Not applicable	Pretreatment as required by the irrigation technology, but not less than primary sedimentation

[a] In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.

[b] *Ascaris* and *Trichuris* species and hookworms; the guideline limit is also intended to protect against risks from parasitic protozoa.

[c] During the irrigation season (if the wastewater is treated in WSP or WSTR which have been designed to achieve these egg numbers, then routine effluent quality monitoring is not required).

[d] During the irrigation season (faecal coliform counts should preferably be done weekly, but at least monthly).

[e] A more stringent guideline limit ($\leqslant$ 200 faecal coliforms/100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.

[f] This guideline limit can be increased to $\leqslant$ 1 egg/l if (i) conditions are hot and dry and surface irrigation is not used or (ii) if wastewater treatment is supplemented with anthelmintic chemotherapy campaigns in areas of wastewater reuse.

[g] In the case of fruit trees, irrigation should stop two weeks before fruit is picked, and no fruit should be picked off the ground. Spray/sprinkler irrigation should not be used.

- Category C: For localised irrigation of category B crops, provided that workers and the public are not exposed to the wastewater, then primary sedimentation is required as a minimum level of treatment. According to Table 4 this would typically contain $5x10^6$ E.Coli and $5x10^5$ Faecal Streptococci.
- Category B: For restricted irrigation of cereal crops, industrial crops, fodder crops, pastures and trees; faecal coliforms must be reduced to less than or equal to $1x10^5$. According to Table 5 secondary treatment would typically be required as a minimum to achieve the required faecal coliform concentrations, while additional

[9] *WHO: Microbiological Guidelines for Treated Wastewater Use in Agriculture [http://www.who.int/bulletin/archives/78(9)1104.pdf]*

treatment/retention in polishing ponds or filtration are also likely to be required to ensure intestinal nematode egg numbers are reduced to less than or equal to 1/litre. In reality, tertiary treatment may typically be required to ensure that this level of water quality could be consistently achieved.

- Category A: For unrestricted irrigation of (uncooked) vegetables, salads, sports fields and public parks; Table 4 and Table 5 confirm that several stages of wastewater treatment will be required including primary treatment, secondary treatment, retention in polishing ponds/filtration and subsequent disinfection techniques.

Chemical pollutants should also be considered, however diseases related to chemical exposures are harder to detect because the health outcomes may take longer to develop and are often caused by many different chemicals through a variety of exposure routes[10]. While for example, cooking of crops irrigated with wastewater can significantly reduce pathogen numbers, this practice has no effect on chemical pollutant concentrations. The WHO have developed a tolerance matrix for human consumption of chemical pollutants as a guideline (Table 6).

Table 6: Maximum tolerable soil concentrations of various toxic chemicals based on human health protection[11]

Type	Chemical	Soil Concentration (mg/kg)
Element	Antimony	36
	Arsenic	8
	Barium	302
	Beryllium	0.2
	Boron	1.7
	Cadmium	4
	Fluorine	635
	Lead	84
	Mercury	7
	Molybdenum	0.6
	Nickel	107
	Selenium	6
	Silver	3
	Thallium	0.3
	Vanadium	47
Organic Compound	Aldrin	0.48
	Benzene	0.14
	Chlordane	3
	Chlorobenzene	211
	Chloroform	0.47

[10] *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Volume 1 Policy and Regulatory Aspects, WHO, 2006*

[11] *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Volume 1 Policy and Regulatory Aspects, WHO, 2006*

	2,4-D	0.25
	DDT	1.54
	Di-Chlorobenzene	15
	Dieldrin	0.17
	Dioxins	0.00012
	Heptachlor	0.18
	Hexachlorobenzene	1.4
	Lindane	12
	Methoxychlor	4.27
	PAHs (as benzo[a]pyrene)	16
	PCB's	0.89
	Pentachlorophenol	14
	Phthalate	13733
	Pyrene	41
	Styrene	0.68
	2,4,5-T	3.82
	Tetrachlorethane	1.25
	Tetrachloroethylene	0.54
	Toluene	12
	Toxaphene	0.0013
	Trichloroethane	0.68

Many of these chemicals are not typically naturally found in domestic wastewaters at toxic levels. Elevated concentrations of such contaminants is usually associated with industrial inputs. As a result, concentrations will be highly site specific, hence it will not be possible to discuss general required removal rates of chemical pollutants in this section of the report.
During piloting there will be a requirement to collect representative samples of received wastewater and treated effluent for analysis of chemical contents. This can be used to assess any potentially toxic levels in the received waters and identify typical removal efficiencies for the INNOQUA technologies.

The guidelines for use of wastewaters that we have reviewed consider health protection considerations for both consumers of crops irrigated with wastewater derived effluents and also workers and farmers who may be exposed during the irrigation process. For the purpose of the INNOQUA project we must also consider any legislation or guidelines associated with the protection of those who will operate and maintain the equipment associated with the various wastewater treatment processes.

The hazards associated with working on wastewater treatment plants are much the same as those for farmers working on wastewater irrigated land and consumers of wastewater irrigated crops, typified by exposure to pathogenic organisms. Resulting illnesses include:

- Gastroenteritis
- Weil's disease
- Hepatitis
- Occupational Asthma
- Skin or eye infections[12]

The UK HSE have outlined the following measures to assist employers in protecting employees that may come into contact with sewage form infection and illness. These include:

- Raise awareness of the hazards and risks through proper instruction, training and supervision
- Provide task specific personal protective equipment
- Ensure that a proper system is put in place for the inspection and maintenance of equipment
- Provide suitable welfare facilities including soap and clean water
- Provide suitable first-aid equipment
- Make effective arrangement for monitoring the health of the workforce.

Although these guidelines are designed for the UK, the same exposure routes and potential for infection exists worldwide. It will be important to ensure that these rules are complied with during piloting and potentially through full scale application of the INNOQUA technologies thereafter.

The INNOQUA project will review the treatment capacity of de-centralised, small-scale treatment solutions including the Lumbrifilter, Daphniafilter and UV technologies. A combination of these technologies will be piloted at various locations around the world to identify the achievable level of treatment (including both pathogen reduction and chemical pollutant removal) to derive the effluent quality of the produced wastewaters and also, considering the pathogen removal for each treatment stage, derive the potential uses for the produced effluents.

2.1.1 Primary/Secondary Wastewater Treatment - Lumbrifilter

The Lumbrifilter utilises specifically cultured earthworms and aerobic bacteria to degrade pollutants in wastewaters. Preliminary trials at household scale have seen typical removal rates of up to 97% BOD, 94% TSS and 79% COD. Additionally, 46% of E-coli was removed along with 68% of intestinal enterococcus. For a typical wastewater containing 1 x 10^7 E.Coli, this would produce an effluent containing approximately 5.4 x 10^6.

According to Table 5 this would certify such wastewaters as a category C wastewater (possibly suitable for irrigation of Category B crops provided that workers or the public do not come into contact with such waters.

[12] *HSE UK 1996, Working with Sewage, The Health Hazards, A Guide for Employers [http://www.hse.gov.uk/pubns/indg198.pdf]*

Additional benefits of this technology over other alternates include zero sludge production and substantially reduced energy usage, hence reduced operational cost when compared to conventional secondary wastewater treatment processes.

2.1.2 Tertiary Solids and Pathogen Reduction - Daphnia Filtration

The Daphnia filter utilises specifically cultured zooplanktonic species to further reduce suspended solids and pathogen concentrations in secondary treated wastewaters. Previous trial sites have indicated that at a 4-day retention time, the daphnia filter can produce a 2.7 log inactivation of E-Coli. When utilised as a tertiary treatment for Lumbrifilter effluents, it may be possible to reduce pathogens in the subsequent wastewaters to concentrations acceptable to use as a Category B irrigation water (possibly suitable for cereal, industrial and fodder crops, provided that only workers of age >15 have minor exposure to such waters). Added benefits of this technology are that this process is reported to be capable of ~50% removal of N and P, 99% removal of suspended solids and up to 80% removal of emerging and priority organic pollutants.

2.1.3 Disinfection – Bio-solar Purification (BSP)

The BSP is inoculated with suitable species of microorganism prior to operation and is designed to maximise the exposure of treated effluent to UV radiation from sunlight for the removal of dissolved compounds and disinfection. Removal rates will be determined during piloting, though it is anticipated that effluent quality will be such that the water could be re-used for irrigation, aquifer recharge and domestic use. An added environmental advantage for this technology is that as it's only source of additional carbon is in the form of gaseous CO_2, this can be sourced from by-products from other processes such as flue gas or fermentation gases. The process is also a net producer of oxygen, which may be harnessed and utilised for aeration purposes within the Lumbrifilter and/or Daphniafilter.

2.1.4 Disinfection – UV Treatment

A UV lamp system will be trialled that utilises innovative new lamp driver technology in combination with newly designed highly efficient UV reactors. This process is designed for optimal hydronomical conditions which ensure even distribution of UV light through received effluents. UV technology is now widely used in the treatment of wastewater and drinking water. The quality of the final UV treated water is largely dependent on the quality of the received waters. The pilot trials will determine the treatment capabilities of the technology and identify the most suitable re-use applications.

In addition to the suitability of the selected technologies in terms of their treatment capacity and the specific requirement/demand for re-usable water, economic considerations will also play a big part in the suitability of the technologies for a given application.

The availability of funds for improved sanitation projects can come from many streams including international, continental, national, regional or local governmental schemes, from the private

sector or from NFP's and charities. As a result, the specific funding streams for each application is highly site specific. This report will look at the available funding streams and other economic considerations that may influence the potential success of these technologies for a given application.

3 Africa

3.1 Tanzania

In Tanzania, different laws and policies govern and give mandate to respective institutions to provide required sanitation facilities and oversee service provision. The legal and regulatory frameworks for waste water management cover collection, transport, treatment and disposal of human excreta and domestic waste water. In regards to waste water management, this framework makes provisions on environmental and health factors as well as regulation of service provision.

The National Water Policy (2002) developed by the Ministry of Water and Irrigation sets out the legal and regulatory framework for water supply and sanitation in the country. This includes the Water Supply and Sanitation Act, DAWASA Act and EWURA Act. Under this framework, Water Supply and Sanitation Authorities and Water Utilities for regional centres and small towns respectively are mandated with sanitation and sewerage service provision. They are regulated by the Energy and Water Utilities Regulatory Authority (EWURA).

The environmental aspects for waste water treatment are regulated by the National Environmental Policy (1997), the Environmental Management Act (2004) and underlying Environmental Impact Assessment and Audit Regulations (2005). Environmental Standards are enforced by the National Environment Management Council (NEMC). Standards are developed by the Tanzania Bureau of Standards (TBS). The Vice President's Office is responsible for environmental policy formulation.

Other policy statements address sanitation aspects that promote protection of the environment for sustainability of other sectors, including mining, energy, tourism, fisheries, industries etc.

Health Factors for sanitation are regulated by the Public Health Act and its regulations, which mandate the Local Government Authorities to oversee the implementation of sanitation services at the local government level. At the national level, the National Sanitation Campaign establishes institutional links between the Ministry of Water, Ministry of Health and Social Welfare, Ministry of Finance and President's Office- Local Government Authority, for coordination of implementation of water sanitation and hygiene promotion at the household level, in public places and schools.

3.1.1 Environmental Legislation and Considerations

The environmental legislation on sanitation relating to waste water treatment covers mainly sewerage and onsite sanitation, and gives mandate to specific government institutions to make and enforce laws and by-laws for environmental protection.

The National Environmental Policy (NEP) of 1997 provides guidance and planning strategies for mainstreaming environmental issues in sectoral and cross sectoral policies. This is achieved

through deployment of the policy instruments across various agencies of the government, to promote coordination and cooperation among them. Instruments for National Environmental Policy include:

- Environmental Legislation
- Environmental Impact Assessment
- Environmental Standards and Indicators
- Economic Instruments and lastly,
- Precautionary approach.

This Local Government (Urban Authorities) Act (1982) states that it is the duty of the Local Government Authority to maintain in good order all public latrines, urinals, cesspools, rubbish bins and provide for removal of night soil and the disposal of sewerage from all premises and houses in its area, so as to prevent injury to health[13]. The Act further provides that the Local Government Authorities should establish, maintain and carry out services for the removal and destruction of and otherwise dealing with night soil and all other kinds of refuse[14].

Following the implementation of Decentralisation by Devolution (D by D), the President's Office-Regional Administration and Local Government (PO-RALG), is responsible for provision of public services and collection of respective fees.

In relation to onsite sanitation, Local Government Authorities are involved in the following activities:

- Promotion of hygiene and sanitation
- Checking the effectiveness of latrines, septic tanks etc. when issuing building or premises plans
- Training of masons
- Inspection of households, commercial properties and public spaces (monitoring and enforcement). Household inspections are meant to check the quality of latrines, as well as systems for disposal of brown water
- Licensing of private sector pit latrine emptiers
- Some residual role in emptying pit latrines

The Energy and Water Utilities Regulatory Authority (EWURA Act 2001) is mandated to regulate networked services related to either supply of drinking water or removal of waste water provided by Water Supply and Sanitation Authorities (WSSAs) in regional and district headquarters, small towns, and national projects areas, while DAWASA and DAWASCO fulfil these functions for Dar es Salaam City and parts of Bagamoyo and Kibaha.

[13] *Local Government (Urban Authorities) Act (1982), S.55 (g)*
[14] *Local Government (Urban Authorities) Act (1982), Specification – item 49.*

Powers to regulate the water supply and sanitation service providers emanate from EWURA Act, Cap 414; Water Supply and Sanitation Act, Cap 272; and Dar es Salaam Water Supply and Sewerage Authority Act, Cap 273.

The functions conferred to EWURA in relation to water supply and sanitation services include, among other things, to monitor water quality and standards of performance for the provision of water supply and sanitation services (The Water Supply and Sanitation Act (Cap 272): Section 28(1) (e)) and DAWASA Act, CAP 273: Section 26(d).

As a regulator, EWURA employs 3 types of regulation mechanisms namely;

- Technical Regulation
- Economic Regulation and
- Licencing

Technical regulation includes regulation of the quality of service standards, codes of practice, health and environmental issues of water utilities. The water and waste water Quality Monitoring Guidelines (2014) issued by EWURA help Water Utilities to monitor water and waste water quality; in conformity to the TBS standards on drinking water and waste water.
There are two types of water and wastewater quality monitoring, namely Check Monitoring and Audit Monitoring.

i. Check monitoring regularly provides information as to whether the water quality complies with the relevant parametric values laid down in the latest Tanzania Standard (TZS 789:2008).
ii. Audit monitoring provides information necessary to determine whether or not all the parametric values specified in the latest Tanzania Standard (TZS 860:2005) are complied with, See Table 7 for these standards.

The Water Supply and Sanitation Authorities (WSSAs) are required to report to EWURA monthly or quarterly for the conduct of check monitoring, and annually for internal audit monitoring. EWURA or its delegated agency conducts wastewater quality monitoring as external auditor using an expanded list of quality parameters.

The National Water Policy (NAWAPO, 2002) provides a comprehensive framework for sustainable development and management of water resources and puts in place an effective legal and institutional framework for its implementation. The policy objective on water quality identifies pollution from point and non-point sources of water resources as a major factor responsible for the deterioration of the quality of water, making water unusable and its treatment very costly. Increased human activities including poor land use practices, as well as uncontrolled abstractions and pollution of water bodies has an impact on the quantity and quality of the available water resources. Sanitation policy objectives for rural areas aim to improve

health through integration of water supply, sanitation and hygiene education. For urban areas, the policy advocates environmentally-friendly technologies for waste water treatment.

NAWAPO therefore integrates environmental safeguards into water resources management, as means to address pollution and its effects on the environment and livelihoods.

The Environmental Management Act, 2004, provides the legal and institutional framework for sustainable management of the environment in implementation of the National Environmental Policy (1997).

The Act gives mandate to different institutions to manage environmental issues. Pertaining to onsite sanitation, the Environmental Management Act establishes the following institutional structure:

- National Environmental Advisory Committee (NEAC) with the role of advising the Minister responsible for Environment, on matters relating to protection and management of the environment.
- The National Environment Management Council (NEMC) which has an advisory role and is responsible for law enforcement and compliance on pollution control.
- Sector Environmental Sections are allocated the role of overseeing environmental management relevant to the Water Sector to ensure harmonisation of environmental laws into sector legislation, regulations, policies and plans through strategic environmental assessment. This function is designated to the Sector Environmental Coordinators
- Regional Secretariats are empowered to coordinate and give guidance on environmental management in their respective regions, and this function is designated to Regional Environmental Management Experts (REMEs).
- Local Government Authorities are mandated with responsibility for construction, operation and maintaining economic, social and environmental infrastructure. The Act also empowers LGAs (City, Municipal, District, Township) to establish local environmental policies and regulations. These functions are designated to Environmental Management Officers and Environmental Committees.

Onsite disposal of liquid waste is governed by provisions made under S.123- S. 127 of this Act, whereby:

- S.123 (1) Local government may prescribe and issue guidelines on how liquid waste from domestic and commercial premises is to be treated and finally disposed of, both within the site or outside the premises.
- S. 123 (2) The Minister may also prescribe specific guidelines to be followed by the LGAs or Sewerage Authorities in their disposal of general or specific types of liquid wastes.
- S. 124 Transport and disposal of liquid Waste

LGA shall with respect to their areas of jurisdiction, prescribe, issue guidelines and standards on how sewerage from cesspool and sludge from septic tanks is to be collected and transported by specified vehicles for disposal.

- S. 125 Treatment of Liquid waste

The LGA shall ensure that sewerage is appropriately treated before it is finally discharged into water bodies and open land and that it does not increase the risk of infections or ecological disturbance and environmental degradation.

- S. 126 Liquid waste disposal

The LGAs shall designate and ensure compliance with designated disposal ponds, sewerage treatment facilities and sewer points.

- S. 127 Control and Monitoring of sewerage system

Upon completion of construction of a sewerage system, LGA shall facilitate the carrying out of initial and subsequent periodic tests to ascertain that effluent meant for final disposal meet the standards as may be prescribed by the Minister.

It is important that all the institutions mandated to manage environmental factors by the EMA Cap 191, are made aware of the new bio-based technology for onsite sanitation, to obtain necessary approvals and validation of the technology for market introduction.

NEMC has recently issued procedures for carrying out EIA and Environmental Audit, pursuant to S. 81 of the Environmental Management, 2004 Act Cap 191 and EIA and Audit Regulations of 2005. The First Schedule of the Regulations provides two types of project categories: Type A covers projects that require mandatory EIA (those with significant adverse environmental impacts), while Type B projects require only preliminary environmental assessment (where projects are likely to have some significant adverse environmental impacts but the magnitude of the impact are not well known).
As per the First Schedule, waste treatment and disposal projects – waste treatment plants, marine outfall, night soil (septage) collection, transport and treatment as well as construction of sewerage systems – fall under the Type A project category and hence require mandatory EIA, which must be carried out prior to the commencing or financing of the project.

The Environmental Management (Water Quality Standards 2007) Regulations set quality standards for water and sewerage to protect water sources and ground water. The regulations also stipulate management of water pollutant discharge permits, water quality compliance and enforcement.

The First Schedule of the Regulations provide permissible limits for Municipal and Industrial effluents – “Physical” Components (BOD, COD, colour, pH range, temperature, total suspended solids, turbidity), Organic and Inorganic components as well as microbiological components (total coliform organisms), see Table 7. A list of the required analytical methods is provided in Annex 2.

Table 7: Discharge limits (physical, chemical and biological) for municipal and industrial effluents

Physical Components	
Parameter	**Limit**
BOD5 at 20°C	30 mg/l
COD	60 mg/l
Colour	300 TCU
pH range	6.5-8.5
Temperature range	20-35°C
Total Suspended Solids (TSS)	100 mg/l
Turbidity	300 NTU
Inorganic Components	
	Limit (mg/l)
Aluminium (as Al)	2.0
Arsenic (As)	0.2
Barium (Ba)	1.5
Cadmium (Cd)	0.1
Chromium (total)	1.0
Chromium VI	0.1
Chlorides (Cl^-)	200
Cobalt (Co)	1.0
Copper (Cu)	2.0
Fluorides (F^-)	8
Iron	5.0
Lead (Pb)	0.1
Manganese	5.0

Mercury (Hg)	0.005
Nickel (Ni)	0.5
Nitrates (NO_3^-)	20
Phosphorus Total (as P)	6
Selenium (Se)	1.0
Silver (Ag)	0.1
Sulphate (SO_4^{2-})	500
Sulphides (S^-)	1
Tin (Sn)	2.0
Total Kjeldahl Nitrogen (as N)	15
Vanadium	1.0
Zinc (Zn)	5.0
Organic Components	
Parameter	**Limit (mg/l)**
1, 1, 2 -Trichloroethane	0.06
1,1,1 - Trichloroethane	3.0
1,2 - Dichloroethylene	0.2
1,2 - Dichloroethane	0.04
1,3 - Dichloropropene	0.2
Alkyl benzene sulfonate (ABS)	0.5
Aromatic nitrogen containing compounds (e.g., aromatic amines)	0.001
cis-1, 2 - Dichloroethylene	0.4
Dichloromethane	0.2

Oil and grease (fatty matters and hydrocarbons)	10
Organochlorine pesticides (Cl)	0.0005
Other aromatic and/or aliphatic hydrocarbons not used as pesticides	0.05
Pesticides other than organochlorines	0.01
Phenols	0.002
Tetrachloroethylene	0.1
Tetrachloromethane	0.02
Trichloroethylene	0.3
Microbiological Components	
Parameter	**Limit**
Total Coliform Organisms	10,000counts/100mL

The 8th Schedule prescribes the minimum allowable distances of various wastewater systems from water courses (Table 8).

Table 8: Wastewater systems and required distance from drinking water source

Source of contamination	**Minimum distance from drinking water source**
Pit preview, septic tanks and sewers.	50 metres
Borehole latrines, seeping pits, trenches and sub surface sewage disposal fields.	100 metres
Cesspools, sanitary landfill areas and graves.	150 metres

The water quality standards and indicators are enforced by NEMC through their Environmental Management Officers, at various levels of the Local Government Authority.

The Water Resources Management Act, 2009 established the 9 Basin Water Boards to oversee management of water resources in Tanzania. In relation to water treatment, the Basin Water

Board is mandated to issue permits for effluent discharge permits to respective industries and other establishment, together with monitoring of the waste water quality standards.

3.1.2 Health Legislation and Considerations

The Ministry of Health and Social Welfare, through its Directorate of Preventive Health Services, is overseeing the implementation of sanitation and Hygiene Promotion activities in Tanzania. Other Ministries with responsibility to promote sanitation and hygiene in the country include, President's Office – Regional Authorities and Local Government (PO-RALG), Ministry of Water and Irrigation, Ministry of Finance, Ministry of Education and Vocational Training and other implementing Agencies (UNICEF, GIZ, WaterAid, T-Mark and Water and Sanitation Program). These key Ministries are coordinated through the Development Partners Group on Health Promotion (Sanitation, Hygiene, Environmental Health Management and Climate Change).

The working group has 3 sub technical working groups:

- School Water, Sanitation and Hygiene (WASH),
- Household sanitation and hygiene and
- Environmental Health and climate change

A number of programs and guidelines have been developed including:

- National Sanitation Campaign that was launched in 2012 and respective guidelines for its implementation.
- School Water, Sanitation and Hygiene Guidelines
- National Waste Management Guidelines (DRAFT)
- Regulations on Sanitation and Hygiene (DRAFT)
- Sanitation and Hygiene Policy (DRAFT)

The National Sanitation Campaign, Phase 1 (2011-2015) program is implemented under Component II of the by the Ministry of Water and Irrigation in collaboration with the Ministry of Health and Social Welfare (Coordinator), PO- RALG and other Implementing Agents. Launched in 2012, Phase I of the campaign aimed to provide 1.52 million rural households with improved sanitation facilities and 812 schools with appropriate WASH facilities by 2015. Key activities identified for National Sanitation Campaign includes;

- Rehabilitation of WASH facilities in Schools
- Advocacy and Sensitisation
- Baseline Data Collection
- Engagement of communities through Community Led Total Sanitation[15] and promotion events
- Training of sanitation service providers
- Monitoring and Evaluation

[15] CLTS is a methodology for mobilising communities to completely eliminate open defecation, whereby communities are facilitated to conduct their own appraisal and analysis of open defecation and take their own action to become open defecation free.

Phase II (to be starting), will expand to urban areas and public places (hospitals, health care centres etc.)

National Sanitation Campaign (NSC) implementation guidelines recognised the crucial role of the LGA and the importance of law enforcement, whereby the LGA is responsible for identifying non-compliant households and institutions, issuing notices as the law requires and instituting legal measures against non-compliance.

National sanitation options and construction guidelines are in place and provide guidance on selection, design and construction of sanitation facilities for households, public places, health facilities and learning institutions.

School Water, Sanitation and Hygiene (SWASH) guidelines give specific guidance for construction and maintenance of water supply and sanitation facilities in public schools. These set minimum standards for service provision and guidance on hygiene promotion in public schools.

Pertaining to health promotion, the Health Sector Strategic Plan III has a specific objective to operationalise the Public Health Act (2009) and Environmental Management Act (2004).

In particular, the Public Health Act, 2009 mandates LGAs to:

a) Set aside areas of adequate size for the purpose of solid and liquid waste disposal;
b) Manage the disposal areas to control the occurrence of any nuisance or disease;
c) Collect, transport and dispose of solid and liquid waste from buildings, premises and land;
d) Collect, transport and dispose of solid and liquid waste from any trade or business premises;
e) Cleanse earth closets, privies, latrines and other receptacles for waste and sewerage substances and;
f) Maintain waste water drains

The LGAs are authorised to charge a fee for a service provided to a service beneficiary (whether through themselves directly, or via an agent), and revenue collected from the services will be used for the improvement of environmental health services.

The LGAs are required to make by-laws prescribing simple and appropriate technological options for the disposal of human excreta waste, standards for excreta waste management and provision of penalties for defaulters.

The LGAs also monitor provision of latrines in building or premises plans, and issue notices in respect of existing building premises that lack sufficient latrine accommodation or latrines that are in unsatisfactory condition.

3.1.3 Economic Legislation and Considerations

The economic instruments for policy implementation primarily follow the polluter-pays principle which make the party responsible for causing pollution pay for damages done to the environment, or face penalties in case of breach. Notably, the law stipulates two types of offences and their respective penalties:

1. Offences relating to environmental standards:

Where any person who contravenes the environmental standards is liable on conviction to a fine not less than 2 Million Tshs, but not exceeding 10 Million Tshs, or imprisonment for a term not less than 2 years but not exceeding 7 years or to both.

2. Offences relating to pollution:

Any person who commits an offence relating to pollution is liable on conviction to a fine of not less than 3 Million Tshs but not exceeding 5 Million Tshs, or to imprisonment for a term not exceeding 12 years or to both.

Voluntary compliance is also encouraged. Other economic instruments include regulating user charges and permits to attract efficient management of natural resources.

Economic regulation within the EWURA Act 2001 includes regulation of:

- Level of Investments
- Planning and Procurement of major Projects
- Reviewing and setting of rates and charges

The Energy and Water Utilities Regulatory Authority Act, Cap 414 gives EWURA the mandate to issue, renew and cancel licences of service providers in the regulated sectors. Existing licence holders and potential licence applicants may submit their applications to EWURA for a new licence or licence renewal. EWURA considers licence applications and decides whether or not to grant a licence or licence renewal by using fair and non-discriminatory procedures.

3.1.4 Conclusions

Provision of sanitation services cuts across various sectors, regulation of which requires understanding of various sectoral policies, laws and regulations. These are summarised in Annex 1. To understand the legal and regulatory framework for sanitation services, two important classifications need to be made.

The first distinction is between public and domestic service provision. Legal and regulatory provisions in the principal Acts are used to regulate public service, while by-laws that are created at the local government level are used to regulate sanitation at household level.

The second distinction is between the urban and rural context. This particularly applies to whether there are sewer networks or public sanitation facilities managed by the Water Utilities or not. In the urban context Water Supply and Sanitation Authorities for Regional Capitals, and

Water Utilities for small towns are responsible for providing sewerage and sanitation services. Pertaining to sanitation, EWURA regulates only WSSA with sewer networks. For areas without sewer networks, LGAs are responsible. However, in both cases, respective authorities are required to apply for waste water discharge permits to the Basin Water Boards. In the rural context, sanitation at household level is a private affair. However, Community Water Supply Organisations, Health Committees and other bodies are responsible for formulation and enforcement of by-laws.

In conclusion, in the absence of one specific sanitation law, understanding of the individual Environmental, Public Health together with Water Supply and Sanitation laws is relevant when considering the introduction of a new sanitation technology. For construction of public sanitation facilities, institutional clearance will at minimum include:

- Directorate of Preventive Health Services, at the Ministry of Health;
- Project registration at the National Environmental Council prior to financing or construction;
- Environmental Impact Assessment and other clearances from the Local Government Authorities, which may vary geographically;
- Approval from EWURA for any investments by the Water Supply and Sanitation Authorities.

4 Eastern Europe

4.1 Romania

Romania's transition to a free-market economy began with the adoption of its new Constitution in 1991. In the post–Cold War period, Romania developed closer ties with Western Europe and was accepted into NATO in 2004 and the EU in 2007. In addition to its strategic position on the Black Sea, Romania has extensive natural resources, a productive agriculture sector, and the potential for strong growth in industry and tourism.

4.1.1 Environmental Legislation and Considerations

Relevant documents in the Project field of interest as, e.g., the Water Framework Directive (EU WFD, 2000) its daughter Directives and associated Documents (e.g., WFD Strategy, 2012), the UWWTP Directive (UWWTPD, 1991), establish a framework of action, planning an institutional approach that will ultimately lead to a better environment and to a sound management of EU water systems, while preserving nature and protecting public health. Major discrepancies among EU Member States constitute a barrier to this approach. Romania strives to observe deadlines established by the *aquis communitaire* but Action Plans and institutional coherence must be doubled by a vast investment programme to clean up the environment, to commission new, state-of-the-art WWTPs and to implement best available technologies in the existing

ones[16] . However, current efforts focus on ensuring water and wastewater treatment for large population agglomerations.
What is specific for Romania comes from the following facts:

a. The state of the environment is strongly affected by the "historic" accumulation of nutrients and hazardous substance, by the unacceptably high share of UWWTP or untreated discharges in polluting river systems[1616].

- 93.33 % in total P emissions
- 85.65 % of the N emissions
- 73.30 % total organic carbon (TOC) and 48.17 % phenols emissions
- a high share in heavy metal emissions (20.52 % of Cd, 69.69 % of Cr, 54.64% Ni, 45.73% of Pb, 57.37 % of Zn(Zn).

The following figures illustrate some of the "historic" environmental pollution sites in Romania. Former mining areas (Valea Jiului, Baia Mare, Comanesti, etc.) are regions characterised by increased poverty, social exclusions, unemployment (41%) in which economic difficulties directly impact on the environment and public health[17].

Figure 1: Abandoned site of the carbon-black factory in Copsa-Mica[18]

[16] ANPM (2012) National Report on the State of the Environment, issued by the Romanian National Agency for Environmental Protection.
[17] Pascu, G and Gheorghe T.(2012), "Sustainable Strategies For Controling The Poverty Problems In Former Mining Industrial Sites In Valea Jiului ',Sci Bulletin of the Polytechnic University-Timişoara - Transactions On Hydrotechnics,57(71), pp91-98.
[18] http://totb.ro/poluarea-in-romania-de-la-primii-carbuni-la-panourile-solare/ , accessed Sep 2, 2016

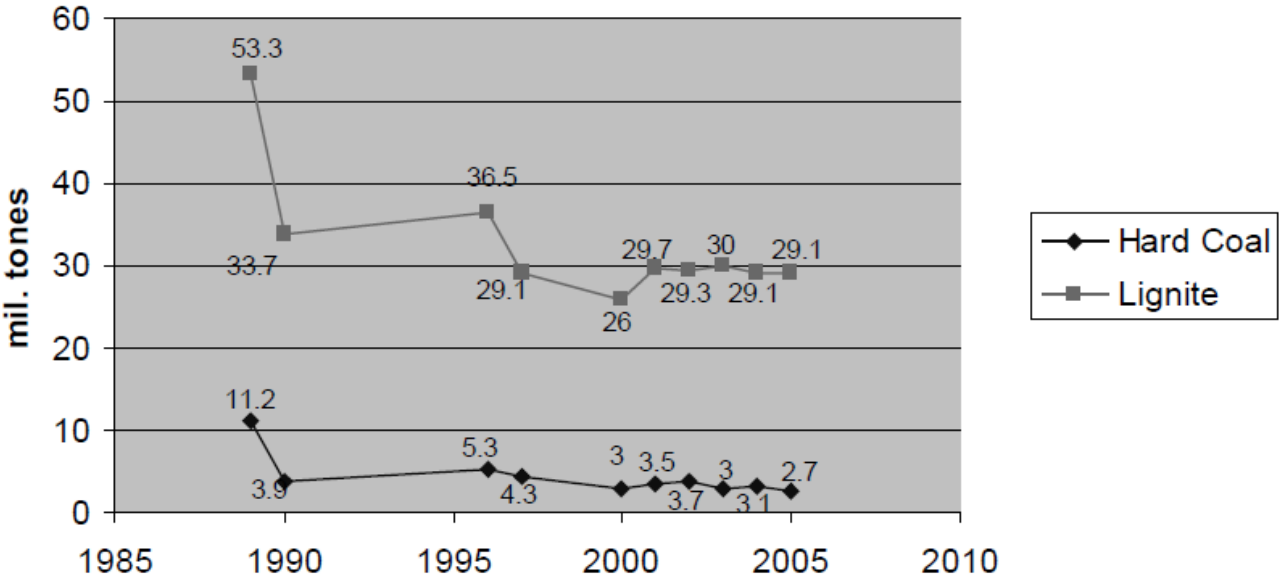

Figure 2: Coal production decline in Romania left vast mining areas still aggressive to the environment.[19]

Figure 3: Abandoned sulphur open-pit mining in the Calimani Mountains[20]. Acid Mine Drainage profoundly affects water, soil and air.

Though 202 UWWTP exist, their technological level and operational parameters does not fulfill, sometimes, the most drastic norms imposed for "sensitive area" as Romania was declared when transposing the Water Directive into Governmental Decisions 188/2002 and 352/2005.

Limited access to basic utilities negatively impacts the quality of life. In 2014, 27 % of the rural population was connected to the public water system (92.7 % in urban areas), and only 5.3 %

[19] *Data from the Romanian National institute for Statistics, http://www.insse.ro/cms/ , ccessed Sep 2, 2016*

[20] *https://avopix.com/tag/premium-photos/calimani*

was connected to sewage (82.8 % in urban areas). Only 34 % of rural households had a toilet inside the house (Figure 4).

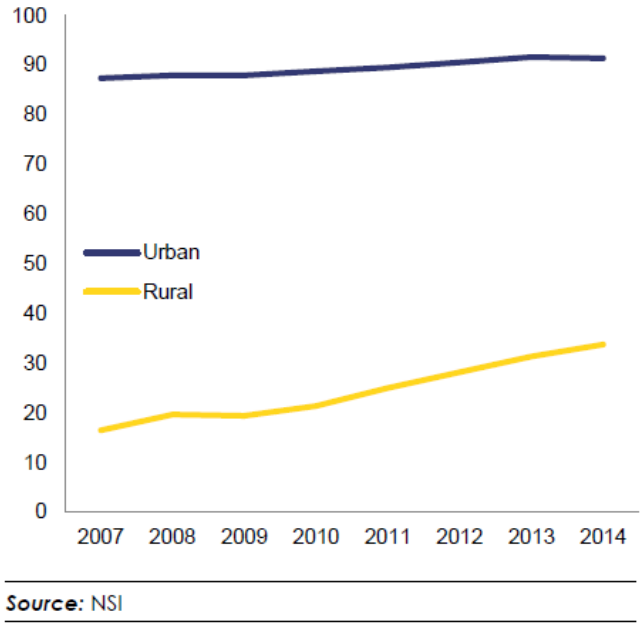

Figure 4: Percentage of households with indoor flushing toilet[21]

b. The low level of awareness about risk associated to water. 67% but what is critical is that those more informed are older people (over 45 years) indicating a critical area for action of the educational system.

c. Limited to inexistent reuse of treated water/sludge from WWTP. 0,2 percentage of sludge was reported to be used in agriculture as fertiliser and same percentage of treated water has been used as water for irrigation (mainly on the premises of the WWTP and surroundings).

For WWTPs in Romania with capacities below 2000 p.e., for municipal waste waters from collection (sewerage) system, are to be “appropriately treated” and the limits are to be as indicated in Table 9. Other particular categories of WWTPs below 2000 p.e. are not defined (e.g. 500 or 50 p.e.).Industrial WWTPs are covered by HG188/2002 and HG 352/2005, if the capacity exceeds 4000 p.e. or 240 kg BOD5 per day. No limits for touristic establishments are specified. However, industrial and touristic establishments WWTPs are usually required by Water Management Permits to meet the most stringent NTPA001 limits.

[21] *Garcia, J.A. and Clapham, C. (2013), Recent Trends in Corporate Governance and Disclosure, Blake, Cassels & Graydon LLP, Vancouver, BC, Canada.*

Table 9: Specific legal discharge limits for small WWTPs[22]

Indicator	Units	Values for < 10000 p.e. and <2000 p.e	Lowest values (for > 100000 p.e.)
pH		6.5-8.5 or 6.5-9.0 for the Danube	6.5-8.5 or 6.5-9.0 for the Danube
BOD5	mg O_2/l	25	25
COD (COD-Cr)	mg O_2/l	125	125
Suspended solids	mg/l	60	35
Total Nitrogen - N	mg/l	15	10
Ammoniacal nitrogen (as NH_4^+)	mg/l	3	2
Nitrate NO_3^-	mg/l	37	10
Nitrite NO_2^-	mg/l	2	1
Total Phosphorus	mg/l	2	1
Sulphides, sum of S^{2-}, HS^- and H_2S, as S^{2-}	mg/l	0.5	0.5
Phenol	mg/l	0.3	0.3
Extrables in organic solvents	mg/l	20	20

The treated waste water can be discharged in terrain drainage channels, agricultural irrigation channel systems or on agricultural soil only after appropriate treatment and only with the permit of the terrain and facility owner or administrator.

Furthermore, when the water from the channel is used for agricultural irrigation, the requirements for the treatment (so, the limits) are to be correlated with STAS 9450/88 -- *Water for irrigation in agriculture*.

When the effluent of the WWTP is discharged into a drainage channel which ends into a natural receiver, the limits will be as in NTPA001.

In Romania the conditions for the marketing of construction products are directed by the EU Regulation No 305/2011 Of The European Parliament And Of The Council. Accordingly, the national institutional frame is established by the Romanian Government Decree 1236/2012 [23].

The Ministry of Regional Development and Tourism is the national authority for the construction domain.

According to the Decree 1236/2012, this Ministry of Regional Development and Tourism (MDRT) is the notifying authority that shall be responsible for setting up and carrying out the

[22] *HG 352/2005 republished http://www.gnm.ro/otherdocs/nsbhrtjqp.pdf*
[23] *Monitorul Oficial al României, Partea I, nr. 876/21.12.2012*

necessary procedures for the assessment and notification of the bodies to be authorised to carry out third-party tasks in the process of assessment and verification of constancy of performance for the purposes of the EU Regulation 305/2011.

The Romanian Product Contact Point for Construction is established by the MDRT[24] (http://www.mdrap.ro/constructii/-4218).

MDRT is responsible for the Technical Assessment Bodies[25], including for the "waste engineering products" according to the Regulation (area 18).

Technical Assessment Bodies were designated and notified, e.g. *Institutul de Cercetări pentru Echipamente şi Tehnologii în Construcţii S.C ICECON S.A* [26],[27] , *Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă URBAN-INCERC* [28] for the area 18 of construction products (included in NANDO, *New Approach Notified and Designated Organisations Information System* database[29]).

According to the Romanian Law of Construction (Law 10/1995 and Law 177/2015):

- The quality assurance of construction includes the certification of performance and compliance of construction products and technical assessment.
- The use of construction products without certification and declaration, under the law, of their performance or compliance is forbidden.
- Using for the design / project or for the execution of the uncertified products or without technical assessments for the works for which is necessary to ensure the appropriate quality basic requirements is also forbidden.

Harmonised standards which can be of interest here:

EN 12566-7:2013, Small wastewater treatment systems for up to 50 PT. Prefabricated tertiary treatment units

EN 12566-4:2016, Small wastewater treatment systems for up to 50 PT. Septic tanks assembled in situ from prefabricated kits

EN 12566-6:2013, Small wastewater treatment systems for up to 50 PT. Prefabricated treatment units for septic tank effluent

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[24] http://www.mdrap.ro/constructii/-4218

[25] *Except fire fighting protection / fire stopping products, which is the responsability of Ministry of Administration and Interior*

[26] *ORDIN nr. 942 din 17 iunie 2014 pentru desemnarea Societăţii Comerciale Institutul de Cercetări pentru Echipamente şi Tehnologii în Construcţii - ICECON - S.A. în vederea notificării la Comisia Europeană ca organism de evaluare tehnică europeană a produselor pentru construcţii*

[27] *Societatea Comercială Institutul de Cercetări pentru Echipamente şi Tehnologii în Construcţii - ICECON - S.A. Adresa: şos. Pantelimon nr. 266, sectorul 2, Bucureşti, tel.: +40(21) 202.55.00, fax: +40(21) 255.14.20, email: icecon@icecon.ro; website: http://www.icecon.ro*

[28] *ORDIN nr. 941 din 17 iunie 2014 pentru desemnarea Institutului Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă URBAN-INCERC în vederea notificării la Comisia Europeană ca organism de evaluare tehnică europeană a produselor pentru construcţii EMITENT MINISTERUL DEZVOLTĂRII REGIONALE ŞI ADMINISTRAŢIEI PUBLICE, în MONITORUL OFICIAL nr. 469 din 26 iunie 2014*

[29] *LIST OF TAB NOTIFIED UNDER DIRECTIVE : Regulation (EU) No 305/2011 - Construction products, Creation Date : 04/10/2016, http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=directive.notifiedbody&dir_id=33*

EN 12566-3:2005+A2:2013, Small wastewater treatment systems for up to 50 PT - Part 3: Packaged and/site assembled domestic wastewater treatment plants.

4.1.2 Health Legislation and Considerations

Health inequalities between rural and urban areas are reflected in the much higher rate of infant mortality, lower life expectancy and vaccination rates for children (Figure 5Figure 5).

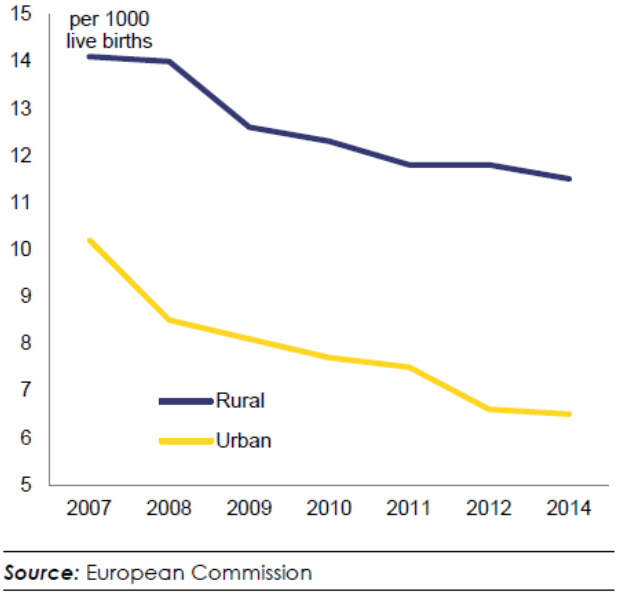

Figure 5: Infant mortality rate[30]

According to Romanian standards[31], water used for irrigation in agriculture is classified based on chemical and microbiological indicators, resulting few categories and sub-categories. Various categories of irrigation water can be used for different soil type and crops.

Hydrogen ion activity (pH) - water used for irrigation has to have a pH value between 5.5 and 8.8.

The salinity of the water for irrigation is to be controlled versus the following indicators:

- TDS,
- electrical conductivity,
- chloride ion concentration,
- sulphate ion concentration,
- sum of hydrogen carbonate and carbonate ion which are associated with calcium and magnesium and sodium to sum of calcium and magnesium.

[30] http://ec.europa.eu/eurostat/statistics-explained/index.php/Mortality_and_life_expectancy_statistics#Infant_mortality
[31] *STAS 9450-88 - Water for irrigation in agriculture*

Depending on the salinity, the water can be used for general purpose irrigation and any soil type, or the use is allowed only for permeable soil or soil with constructed drainage systems and for salinity tolerant plants.

Toxic or harmful indicators which are individually limited are: aluminium, arsenic, beryllium, cadmium, boron, cadmium, cyanide, cobalt, chromium, copper, iron, fluoride, lithium, manganese, molibdenum, mercury, nickel, lead, selenium, sulphide, vanadium, zinc and organochlorinated pesticides.
Water with higher content of these indicators (Type II) can be used only for low quantity irrigation.

Depending on microbiological indicators, the irrigation water quality can fall in the following categories:

Table 10: Irrigation Water Quality Category Standards[32]

Indicator	**Category**		
	M1	**M2**	**M3**
Total coliforms	< 100	100-100000	10^5 - 10^7
Faecal coliforms	absent	<10000	10^4 - 10^6
Faecal streptococci	absent	<10000	10^4 - 10^6
Salmonella	absent/1000cm^3	absent/500cm^3	absent/ 100cm^3
Usability for water as irrigation water	For any soil type and any plants	For any soil type and any plants, **except** highly permeable soil and plants for human or animal consumption in a fresh state or without thermal processing.	Only for soil where water table is below 4 m depth and for the plants which are to be industrialised with thermal treatment and for plants with other uses than food.

4.1.3 Economic Legislation and Considerations

According to the most recent Country Report issued by the European Commission[33], economic growth has been strong over the last three years, gradually broadening its base**.** In the wake of the 2009 crisis the Romanian economy stabilised with the support of EU-IMF financial assistance programmes. It has been expanding strongly since 2013, the drivers of growth switching gradually from net exports to domestic demand. Private consumption recovered to its

[32] *STAS 9450-88 - Water for irrigation in agriculture*
[33] *Romania Country Report, 2016 (published Nov 26, 2015). Available at* http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_romania_en.pdf *, retrieved Sep 3, 2016*

post-2008 peak on the back of higher household disposable income boosted by strong wage growth and negative inflation. Investment was slower to recover but has returned to near pre-crisis growth rates.

Conversely, imports are being fostered by robust domestic demand, but the current account deficit expanded only marginally last year as export market shares continued to grow, especially in the services sector. Fiscal stimuli are expected to boost real GDP growth above potential in 2016-2017. These measures combined with accelerating wage growth will add further pressure on already robust domestic demand. At the same time, policy measures on the supply side of the economy, such as investment in innovation and infrastructure or improvements to the business environment and public administration, remain limited. The main challenge will be to ensure balanced and durable growth in the future.

Recovering from the severe shock of the recent global financial crisis, Romania continues to place a high priority on restoring fiscal sustainability and improving competitiveness by easing and rationalising the regulatory burden. Modest economic growth has resumed, and the government has made progress in reducing the public debt and budget deficit. The pace of privatisation and restructuring of state-owned enterprises has slowed, yielding mixed results. According to the Index of Economic Freedom developed by the *Centre for International Trade and Economics at The Heritage Foundation*[34]*, Romania has an Economic Freedom Score of 65.6 being catalogued with an Economic Freedom Status: Moderately Free. Global Ranking: 61st Regional Ranking: 29th in Europe (*Figure 6*).*

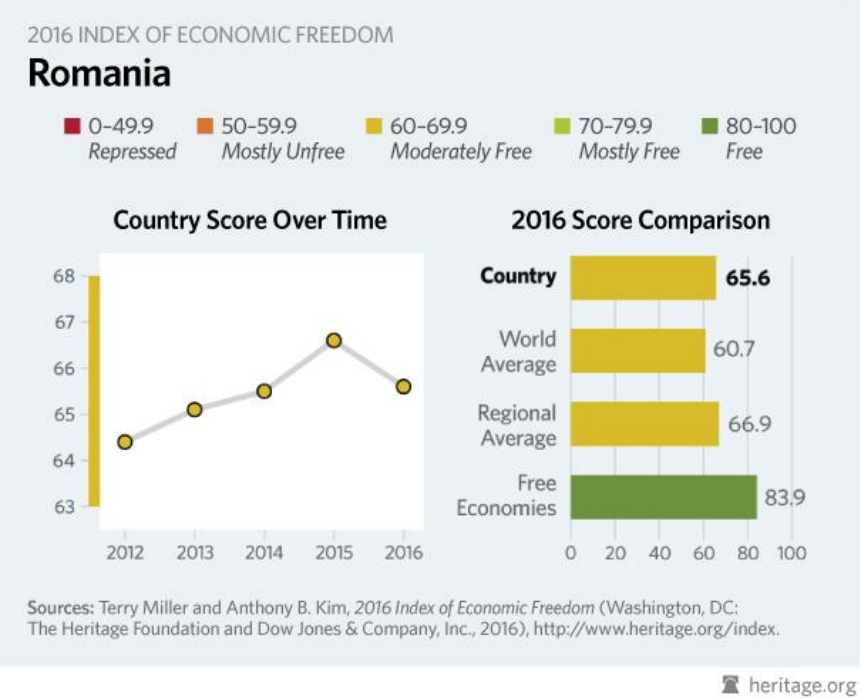

Figure 6: Romanian Index of Economic Freedom

[34] *Romania Economic Freedom Score, available online at: http://www.heritage.org/index/country/romania*

While there has been progress in some areas, partly with the use of European funding, rural areas remain far behind urban areas in terms of poverty reduction, employment and education, access to services and basic infrastructure[35]. Romania's key development disparities are between urban and rural areas. With 46 % of Romania's population living in rural areas and considering the magnitude of some of the challenges, the impact of the rural-urban gap hampers the achievement of national economic and social development targets. The socio-economic development of rural areas is limited by under-developed transport infrastructure and limited public and private transport, coupled with high commuting costs and limited access to broadband infrastructure. Low added value in agriculture and a lack of economic diversification in rural areas constrain the development of a sustainable rural economy.

4.1.4 Conclusions

More specific for Romania are the following observations:

a. Like other Eastern Europe EU Countries, Romania faces the same gap between the legal system, fully aligned to the EU one and its implementation. More than other Eastern European EU Countries, Romania, after 50 years of accelerated irrational industrialisation with no regard for the environment, is confronted with huge problems generated by the “historic” pollution.
b. A central problem for improving the implementation effectiveness of European legislation lies in the impact of national administrative traditions. As a Balkan Country, Romania inherited the Byzantine approach of delaying actions and avoiding responsibilities at the lower administrative levels. While the formal transposition of EU laws is done by the Parliament and generally follows the deadline specified in each legal EU act, the practical implementation is suffering and
c. There are marked regional differences in how the laws are perceived and followed. In Transylvania the process seems more straightforward and the awareness is higher. This comes from the cultural and historic background of different regions of Romania
d. Historic environmental (irrational industrialisation with no regard to the environmental impact) and public health (systemic corruption) problems still affect Romania.
e. Bureaucracy connected to EU funded Projects is not of any help in speeding up the situation in Romania.
f. The bottom-up implementation of EU issued legal documents is a good approach but it must rely on higher education and awareness.
g. The EU system of recording and reporting (EUROSTAT and similar agencies) is essential but it must be operational and objective. Clerks responsible to operate linkage to EUROSTAT will have to go additional training and special measures should be in force if they do not fulfil their tasks.

[35] *European Commission staff working document. Country Report Romania 2016, Including an In-Depth Review on the prevention and correction of macroeconomic imbalances*

5 Western Europe

In Europe significant progress has been made in the provision of adequate waste water facilities mainly due to regulatory pressures. The European Union (EU) Council Directive 91/271/EEC concerning urban waste water treatment (UWWT) was adopted in May 1991. The primary objective of the Directive is to protect the environment from the adverse effects of discharges from urban waste water and industrial sectors.

The Directive defines urban, domestic and industrial waste water as follows; urban waste water is domestic waste water or the mixture of domestic waste water with industrial waste water and/or run-off rain water. Domestic waste water is waste from residential settlements and services, which originates predominantly from the human metabolism and from household activities. Industrial waste water is any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water.

The Directive provides the context for regulation in EU Member States of the collection and treatment of waste water in agglomerations of greater than 2,000 population equivalents (p.e.) and provides the framework concerning UWWT for planning, regulation, monitoring, information and reporting. Specifically, the Directive requires the following;

- The collection and treatment of wastewater in all agglomerations of > 2,000 p.e.;
- Secondary treatment of all discharges from agglomerations of > 2,000 p.e., and more advanced treatment for agglomerations > 10,000 p.e. in designated sensitive areas and their catchments;
- A requirement for pre-authorisation of all discharges of urban waste water, food-processing industry and industrial discharges into urban waste water collection systems;
- Monitoring of the performance of treatment plants and receiving waters;
- Controls of sewage sludge disposal and re-use, and treated wastewater re-use whenever it is appropriate.

In December 2000, the adoption by the EU of further wide-reaching water quality legislation, the EU Water Framework Directive (WFD) 2000/60/EC, ensured the continued commitment of member states to the improvement and maintenance of good ecological status in all water bodies. The UWWT Directive and its requirements now form part of the measures required by the WFD.

The compliance of member states with the UWWT Directive is determined by a facility-specific quarterly, bi-monthly (every two-months) or monthly test and monitoring and subsequent reporting programme which is issued to a sanitary authority as a condition of the operation of the facility. Compliance with such conditions is policed in member states by an identified regulatory authority.

5.1 UK

5.1.1 Environmental Legislation and Considerations

This section will summarise the relevant legislations and code of practises associated with environmental aspects of design, installation and operation of small scale sewage treatment plants, such as the INNOQUA innovative bio-based on-site sanitation systems, in the UK.

All sewage effluent discharges, irrespective of age, volume or location, are subjected to Environmental Agency General Binding Rules. Only sewage treatment plants which have an EN12566-3 Certificate are allowed to discharge into ditches and watercourses. The following legislation applies to sewage treatment plants, septic tanks and foul water soakaways:

- General binding rules for small sewage discharges (SSDs) with effect from January 2015
- Building Regulations (Drainage and Waste Disposal 2015 edition)
- British Standards
- European Standard EN 12566-3 "Small wastewater treatment systems for up to 50 PE"

General binding rules for small sewage discharges in England

New rules came into force on 1 January 2015. Systems were installed and discharging before 31 December 2014 referred as 'existing discharge'. Systems were installed and discharging on or after 1 January 2015 referred as 'new discharge'. The following tables summarises the existing binging rules.

Table 11: Existing binging rules for small sewage discharges[36]

Discharges to surface water	Discharges to ground	General binding rule
Not applicable	Applicable	The discharge must be 2 cubic metres or less per day in volume.
Applicable	Not applicable	The discharge must be 5 cubic metres or less per day in volume.
Applicable	Applicable	The sewage must only be domestic.
Applicable	Applicable	The discharge must not cause pollution of surface water or groundwater.
Not applicable	Applicable	The sewage must receive treatment from a septic tank and infiltration system (drainage field) or a sewage treatment plant and infiltration system.
Applicable	Not applicable	The sewage must receive treatment from a sewage treatment plant.

[36] *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397173/ssd-general-binding-rules.pdf*

Not applicable	Applicable	The discharge must not be within a groundwater Source Protection Zone 1 or within 50 metres from any well, spring or borehole that is used to supply water for domestic or food production purposes.
Applicable	Not applicable	For discharges in tidal waters, the discharge outlet must be below the mean spring low water mark.
Applicable	Applicable	All works and equipment used for the treatment of sewage effluent and its discharge must comply with the relevant design and manufacturing standards i.e. the British Standard that was in force at the time of the installation, and guidance issued by the appropriate authority on the capacity and installation of the equipment.
Applicable	Applicable	The system must be installed and operated in accordance with the manufacturer's specification.
Applicable	Applicable	Maintenance must be undertaken by someone who is competent.
Applicable	Applicable	Waste sludge from the system must be safely disposed of by an authorised person.
Applicable	Applicable	If a property is sold, the operator must give the new operator a written notice stating that a small sewage discharge is being carried out, and giving a description of the waste water system and its maintenance requirements.
Applicable	Applicable	The operator must ensure the system is appropriately decommissioned where it ceases to be in operation so that there is no risk of pollutants or polluting matter entering groundwater, inland fresh waters or coastal waters.

Table 12: Binding rules for a new discharge, which is one that was started on or after 1 January 2015, the following general binding rules also apply[37]

Discharges to surface water	**Discharges to ground**	**General binding rule**
Applicable	Applicable	New discharges must not be within 30 metres of a public foul sewer.
Applicable	Applicable	For new discharges, the operator must ensure that the necessary planning and building control approvals for the treatment system are in place.
Applicable	Not applicable	New discharges must not be in or within: 500 metres of a Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site, biological Site of Special Scientific Interest (SSSI), freshwater pearl mussel population, designated bathing water, or protected shellfish water; 200 metres of an aquatic

[37] *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397173/ssd-general-binding-rules.pdf*

		local nature reserve; 50 metres of a chalk river or aquatic local wildlife site.
Not applicable	Applicable	New discharges must not be in, or within 50 metres of, a Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site, or biological Site of Special Scientific Interest (SSSI), and must not be in an Ancient Woodland.
Applicable	Not applicable	New discharges must be made to a watercourse that normally has flow throughout the year.
Applicable	Not applicable	For new discharges, any partial drainage field must be installed within 10 metres of the bank side of the watercourse
Applicable	Not applicable	New discharges must not be made to an enclosed lake or pond

Building Regulations (Drainage and Waste Disposal 2015 edition)

The Building Regulations 2010 - Drainage and Waste Disposal 2015 edition Part H-H2 Package Sewage treatment Works[38]
The main provisions of these regulations are:

- The Sewage Treatment Plant must be sited more than 7m from habitable property
- The soakaway must be a minimum of 10 metres from a watercourse, 15 metres from a building and 50 metres from a borehole or spring.
- The soakaway must be designed to BS6297: 2007 and all percolation test results must be submitted.
- The discharge point shall be more than 10m from habitable property
- If the discharge is to a soak away a sampling chamber must be provided before the soak away.
- Soakaway drains must be constructed in the aerobic soil layer, i.e. within 700mm. of ground level.

British Standards

The treatment system must meet the relevant British Standard in force at the time of installation. The standards currently in force for new systems are[39]

- BS EN 12566 for septic tanks and small sewage treatment plants

[38] *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/442889/BR_PDF_AD_H_2015.pdf*
[39] *https://www.gov.uk/guidance/general-binding-rules-small-sewage-discharge-to-a-surface-water*

- BS 6297:2007 + Amendment 1 2008

Septic tank or treatment plant met the British Standard in place at the time of installation if:

- it has a CE mark
- the manual or other documentation of tank or treatment plant has a certificate of compliance with a British Standard
- it is on British Water's list of approved equipment

This standard re-enforces the Building Regulations H2 regarding foul water soakaways. There are 3 tests that you MUST undertake to determine whether or not you are allowed to construct or replace a sewage soakaway at all, done in this order: They are all mandatory under Building Regulations[40].

- 1st Test: Ascertain whether or not your soakaway site is in an area designated by the Environment Agency as a Groundwater Source Protection Zone. If it is, then it means that the groundwater underneath your soakaway is used for drinking water and you will not be allowed to pollute it with sewage effluent from a septic tank soakaway.
- 2nd Test The Trial Site Assessment Hole (TSAH): This is a single, large hole which is a minimum 2 metres deep. It is to determine that the water table or bedrock never reaches to within 1m of the bottom of the soakaway pipe. Many sites in the UK fail this vital test and many builders and tank installers never carry one out - until it is too late. If this test fails, then it is pointless doing any percolation tests if you are thinking of installing an underground soakaway.
- 3rd Test The Percolation Tests: If the water soaks away either too fast or too slowly, then a soakaway is not permitted. In general, clay soils will fail and it is not worth performing the tests. This is the test that most people associate with soakaway tests, as it has been mandatory for much longer that the TSAH. The Percolation Test asses the porosity of the soil immediately below and surrounding the 300mm of drainage stone in the trench below the pipe.

European Standard EN 12566-3 "Small wastewater treatment systems for up to 50 PE"

The new Standard for packaged underground sewage treatment units under 50 persons sold in most of Europe is the EN12566-3 2005. The EN12566-3 is also required for CE marking, and CE marking is mandatory in the UK. Any plant, or conversion system, which does not have the EN12566-3 Certificate is illegal to be sold in the UK[41].

The Construction Products Regulations 1991 require Package Sewage Treatment Plants (PSTP) offered for supply in the UK to be watertight, structurally stable, and durable, to have

[40] *http://www.wte-ltd.co.uk/wastewater_legislation.html*
[41] *http://www.ecowa.ro/download/cen12566.pdf*

sufficient treatment capacity and to offer effective treatment for the development in which it is to be installed.

Manufacturers wishing to market underground PSTPs in the UK must be able to provide incontrovertible evidence that their plant satisfies these criteria. This evidence is provided by having the BS EN 12566-3 Certificate,

The EN12566-3 Certificate is absolutely mandatory under the Construction Products 'CE Marking' Directive[42].

Relevant Code of Practice for Small Wastewater Treatment Systems

This section summarises the relevant code of practices applies to small scale sewage treatment plants[43]

- Code of Practice - Maintenance and servicing of Small Wastewater Treatment Systems (Package Plants) up to 50 Population Equivalent
- Code of Practice - Guide for Users of Small Wastewater Treatment Systems
- Code of Practice - Guide to the Installation of Small Wastewater Treatment Systems
- Code of Practice - Flows and Loads 4 (on sizing criteria, treatment capacity for small wastewater treatment systems)
- Code of Practice - Drainage fields for the disposal of septic tank and small wastewater treatment systems effluent

Code of Practice - Maintenance and servicing of Small Wastewater Treatment Systems (Package Plants) up to 50 Population Equivalent

The code of practice defines the ways in which small treatment plants should be serviced and maintained. It also sets out a training and certification scheme where service technicians can obtain a recognised national qualification.

- The National Qualification is a broad based qualification that is aimed at all current experienced technicians of wastewater/sewage treatment plants to advance them all to a recognised level.
- All participants and service companies need to pre-qualify
- The code of practice seeks to be endorsed by the environmental regulators as the preferred methodology of servicing treatment plants up to 50 populations equivalent (pe) and larger plants up to 1000pe.

Code of Practice - Guide for Users of Small Wastewater Treatment Systems

The scope of this guide is to provide background and general information for owners and users of small sewage or wastewater treatment systems to ensure that they work satisfactorily to treat domestic wastewater (sewage) so that the treated effluent meets the regulators requirements and so can be safely discharged to the environment.

[42] *http://www.wte-ltd.co.uk/wastewater_legislation.html*
[43] *http://www.britishwater.co.uk/Publications/codes-of-practise.aspx*

Code of Practice - Guide to the Installation of Small Wastewater Treatment Systems

This guide has been created to enable owners and users to understand the installation of small wastewater treatment systems. It is not a detailed installation guide but a check list of the factors including discharge consent, position of the plant, depth (invert level) of treatment plant, discharge level and access for contractors that should be considered by the owner and the contractor before a package wastewater (sewage) treatment plant or system is installed.

Code of Practice - Flows and Loads 4 (on sizing criteria, treatment capacity for small wastewater treatment systems)

This code of practice was prepared by the British Water Package Sewage Treatment Plant Focus Group comprising of manufacturers, suppliers and service companies of all types of small wastewater treatment systems. Guidance is provided to assist the user to identify the various sources of sewage, to consider the nature of the sewage to be treated and to make users aware of issues which may affect treatability and system performance. This code of practice provides a table of loadings which allows the total daily sewage load from properties to be calculated and it is recommended that all designers should use this table when sizing and designing non-mains sewage treatment systems. The flows and loads values given represent current best knowledge within the UK but may change with time in line with per capita water use.

Code of Practice - Drainage fields for the disposal of septic tank and small wastewater treatment systems effluent

This guide has been created to enable owners and users to understand how the discharge from septic tanks and small wastewater treatment systems (package plants) can be discharged to ground.

Key Points

- Septic tanks can only discharge to ground via a drainage field. Discharge to a watercourse (stream, ditch, pond etc.) is not allowed
- A drainage field is not the same as a soakaway (used for surface water)
- Drainage fields are not permitted in Zone 1 groundwater protection areas
- Drainage fields can only be used where the soil conditions are suitable
- Site tests are required to determine if a site is suitable, and to provide information to design the drainage field
- Drainage fields must be a minimum of 10m from a watercourse, 50m from a water abstraction point and 15m from a building
- They must be at least 1.2m above the water table to prevent short circuiting into the groundwater

5.1.2 Health Legislation and Considerations

In the mid-19th century, as a result of an industrial revolution in the UK, rapid urbanisation and population growth within many of the UK's towns and cities lead to some severe sanitation issues. Taking London as the most famous example, raw sewerage ran through the streets and

into the river Thames. Outbreaks of Cholera were common place, with one particular example in 1853 claiming the lives of over 10,000 London residents.[44]

In 1848 the UK government introduced the Public Health Act, which was the first piece of legislation to place responsibility upon the state for the health and wellbeing of UK citizens. However, it wasn't until 1856 that Dr John Snow proved the link between Cholera and exposure to contaminated water, which in 1858 lead to the government updating legislation that brought about significant improvements in the condition of streets through the installation of sewer networks. By 1866 most of London was connected to a sewer network which ensured that raw sewerage was diverted to newly built sewage treatment facilities. Similar systems were installed throughout many of the other major towns and cities soon afterwards, and many of the sewer networks installed in the UK's towns and cities during this time are still in place today. These changes ensured significant reductions in infant mortality and increases in the average life expectancy in the UK by the end of the 19th century.[45]

The first treatment of sewage was simply through application to land, and by the mid-19th century many cities diverted raw sewage to agricultural land for enhanced crop growth. This practice was enhanced over the years through improved distribution techniques and continued into the 20th century, with the last known system still being used into the 1980's.[85] This practice was eventually abandoned primarily due to them not being able to meet improved hygiene standards.[44]

In the UK today, almost all households are connected to the sewer network. The same is also true for access to the clean drinking water network. Also for wastewater to be suitable for application to land or other re-use purposes, much more stringent legislation on water quality standards must be met as a legal obligation, enforced by the UK Environment Agency.

According to WHO/UNICEF Joint Monitoring Program access to improved water supply and sanitation in the UK is universal. It is estimated that 99.2% of households are connected to the sewer network.Table 13 contains detailed information about the drinking water and sanitation coverage.[45]

Table 13: Drinking water coverage in the UK

United Kingdom	**Drinking water coverage estimates**					
	Urban (%)		**Rural (%)**		**Total (%)**	
	1990	**2015**	**1990**	**2015**	**1990**	**2015**
Piped onto premises	100	100	98	100	100	100
Other improved source	0	0	2	0	0	0
Other unimproved	0	0	0	0	0	0
Surface water	0	0	0	0	0	0

[44] *http://www.water.org.uk/about-water-uk/water-industry/history-uks-sewers*
[45] *http://www.bvsde.paho.org/bvsacd/leeds/cooper.pdf*

Table 14 Sanitation coverage in the UK

United Kingdom	Sanitation coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Improved facilities	99	99	100	100	99	99
Shared facilities	1	1	0	0	1	1
Other unimproved	0	0	0	0	0	0
Open defecation	0	0	0	0	0	0

In England and Wales, the main responsibility for ensuring our drinking water is clean and "wholesome" lies with the water companies which supply it. The standards they must meet are set out in the Water Supply (Water Quality) Regulations 2016, derived from the current EU Drinking Water Directive[46].

At a national level, the Environment Agency is the government body responsible for making sure that the quality of water resources does not pose risk to health and that it is improved when necessary. Threats to 'controlled waters' from historic pollution are regulated under the contaminated land regime. The Drinking Water Inspectorate, part of the Department for Environment, Food and Rural Affairs, oversees the quality of public drinking water supplies.

At a local level, local authorities are responsible under the Water Industry Act 1991 for keeping themselves informed about the wholesomeness and sufficiency of water supplies in their area. Unusually for commercial companies, the water suppliers themselves have some enforcement powers in respect of waste and the risk of contamination by users under the Water Supply (Water Fittings) Regulations 1999. Under the Water Fittings Regulations (Regulation 5) if a customer proposes to install a water reuse system such as the INNOQUA Innovative Bio-based on-site Sanitation system that incorporates a back-up supply from the public mains, the local water company need to be notified. All water reuse systems will be inspected recorded and registered by local water utilities to ensure these Regulations are complied with therefore ensuring public health is protected[47].

Environmental health professionals (EHPs) play an important role in protecting local water quality. As well as sampling the public water supply from time to time, they are responsible for identifying and checking thousands of private water supplies, big and small, under The Private Water Supplies (England) Regulations 2016 in England and their equivalents in the other parts of the UK. Where problems with such supplies are discovered, EHPs work with those who provide them to ensure that the water is improved. If necessary, they can take legal action to achieve this[48].

Other regulation on water quality, which are not directly relevant to INNOQUA Innovative Bio-based on-site Sanitation systems[49]:

[46] *http://www.cieh.org/policy/regulation_water_control.html*
[47] *http://www.anglianwater.co.uk/_assets/media/Water_Reuse_System_2015(1).pdf*
[48] *http://www.cieh.org/policy/regulation_water_control.html*
[49] *http://www.ukmarinesac.org.uk/activities/water-quality/wq1_2.htm*

- The Environment Act 1995
- The Merchant Shipping Act and Merchant Shipping and Maritime Security Act 1997
- (Amendment) Regulations in September 1997.
- The Radioactive Substances Act 1993
- The Water Resources Act 1991
- The Environmental Protection Act 1990
- The Water Act (Northern Ireland) 1972
- The Control of Pollution Act (COPA) 1974
- Water Act 2003

5.1.3 Economic Legislation and Considerations

EU funding

EU funding for water reuse infrastructure is already available under the European Regional Development Fund (ERDF), the Cohesion Fund (CF) and the European Agricultural Fund for Rural Development (EARDF). The Commission will encourage Member States to use these opportunities and prioritise water reuse investments in their Operational Programmes. As an example, water reuse is included in the Thematic Guidance Fiche on Water Management as a key priority for investments in the water sector and action of high European added value for the ERDF and the CF. Investments in water reuse infrastructure can also be eligible for the European Fund for Strategic Investments (EFSI)[50].

Water Utilities

In the UK, water companies could be one of main funding streams, since they have the experience and knowledge. Statistic shows that water utilities invest £5.85 billion in assets each year and £5.17 billion in services[51].

[50] *http://ec.europa.eu/environment/water/reuse-actions.htm*
[51] *https://www.gov.uk/government/publications/water-and-treated-water/water-and-treated-water*

Table 15: Major water utilities (water and sewage) in England, Wels and Northern Ireland

Anglian Water	Thames Water
Dŵr Cymru Welsh Water	United Utilities
Northumbrian Water	Wessex Water
Severn Trent Water	Yorkshire Water
Southern Water	Scottish Water
South West Water	Northern Ireland Water

UK government

Other funding steam could come from the Department for Environment, Food and Rural Affairs (DEFRA), since this governmental body responsible for safeguarding natural environment and water management. According to DEFRA's Single departmental plan: 2015 to 2020 (updated in 15 September 2016) one of the main objective for this period is support of cleaner, healthier environment, benefiting people and the economy. The report state that DEFRA will invest in cleaner air and water including tackling air pollution and clearing up our rivers and waterways. However, the details are not clear yet. DEFRA will publish a framework for action on the environment and develop a 25-year plan by the end of 2016[52].

Cost of permit

In the case of installation of any small scale treatment plant like INNOQUA system, obtaining a permit from the government is necessary. The cost of permit depends on the size of discharge. Fee for discharging up to 5,000 litres (5 cubic meters) per day of domestic treated sewage is £125. Discharging more than 5,000 litres (5 cubic metres) per day, or trade (non-domestic) treated sewage permit fee is £885. Moreover, there's also an annual subsistence fee for these discharges[53] .

5.1.4 Conclusions

The UK and European standards set for the collection, treatment and discharge of wastewaters have been continuously improved, particularly over the past 50 years. The Environment Agency monitor and enforce compliance with these standards in the UK, with businesses and water utilities legally obligated to remain compliant with the standards. In addition to complying with British and European environmental standards, the INNOQUA treatment technologies will need to ensure that the plants comply with UK building regulations for drainage and waste disposal and that the relevant permits for the discharge of wastewaters are applied for. There is a cost

[52] *https://www.gov.uk/government/publications/defra-single-departmental-plan-2015-to-2020/single-departmental-plan-2015-to-2020#a-cleaner-healthier-environment-benefiting-people-and-the-economy*
[53] *https://www.gov.uk/permits-you-need-for-septic-tanks/apply-for-a-permit*

associated with applying for such permits and there are codes of practice in place to assist with such projects that INNOQUA will need to refer to.

There are numerous potential funding streams available for application of the INNOQUA technologies including European funding, UK government funding and funding from Water Utilities, should the INNOQUA technologies prove to be valuable and fit with their innovation and sustainability targets.

5.2 Scotland

Scottish Water operates within a regulatory framework established by the Scottish Parliament in which Scottish Ministers set the objectives for the industry to be delivered at least cost to customers. Key players in this regulatory framework are; the Water Industry Commission for Scotland; the Drinking Water Quality Regulator; the Scottish Environment Protection Agency; the customer representative body, Customer Forum; and for investigation of complaints, the Scottish Public Services Ombudsman.

5.2.1 Environmental Legislation and Considerations

In Scotland the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) applies regulatory controls over activities which may affect Scotland's water environment. This legislation arose from the EC Water Framework Directive (WFD), transposed into law in Scotland through the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act)[54].

The Scottish Environment Protection Agency (SEPA) is the lead body for WFD implementation in Scotland. The CAR regulations enable SEPA to implement the objectives of the WFD, and provide a framework for the protection of the water environment in Scotland.

The following activities are included within the scope of CAR:

- Discharges
- Diffuse pollution
- Abstractions and impoundments
- Engineering works in inland waters
- Groundwater
- Compliance assessment scheme.

Wastewater Discharge

Population Equivalent is the unit of measure used to describe the size of a waste water discharge with a minimum of 5pe used for any house with up to and including three bedrooms. Houses with more than three bedrooms should add 1pe for each additional bedroom1. SEPA

[54] *https://www.sepa.org.uk/regulations/water/small-scale-sewage-discharges/*

like to use these British Water Flow and Loads figures for individual and private developments, but Scottish Water's agreed process for assessing household capacity is to use Scottish average occupancy rate from 2011 census of 2.11.

Under CAR there are three levels of authorisation:

1. General Binding Rules (GBRs) – Only used for low risk activities
2. Registration – Used for low risk activities, which cumulatively pose a risk to the environment
3. Licenses – Where site specific controls are required.

Table 16: Pollution control levels of authorisation www.sepa.org.uk

GBR	Registration	Simple Licence	Complex Licence
Sewage and organic effluents			
	Organic effluents ≤15pe (Including discharges to soakaways)	Organic effluents >15-100pe	Organic Effluents >100pe
	Sewage (Including discharges to soakaways) built before 1 April 2006 ≤50pe, built after 1 April 2006 ≤15pe	Sewage: built before 1 April 2006 >50-100pe built after 1 April 2006 >15-100pe	Sewage >100pe
		Low significance CSOs	Medium and high significance CSOs
			Emergency outflows

On-site Wastewater Treatment Systems

In Scotland, privately-owned individual or community septic tanks and small packaged plants are widely used for the treatment of household wastewater with an estimated 400,000 in use across Scotland. For septic tank discharges SEPA will not typically set numeric conditions but will include a condition that the facility is maintained to ensure the tank will be operating effectively.

Where a package wastewater plant (discharges to soakaway over 15 p.e) requires a CAR licence, the discharge limits of several parameters are prescribed in the licence and are dependent on receiving water capacity, they typically include;

- pH
- BOD (Biochemcial Oxygen Demand)
- COD (Chemical Oxygnen demand)
- Suspended solids
- Ammonia

There are variations depending on the sensitivity of receiving waters which are set on application of a licence.

New sewage discharges resulting from a package treatment plants serving up to 50pe require to be tested and certified to EN12566 Part3 standards[55]. To obtain certification to EN12566, plants must undergo rigorous independent testing which results in a documented average discharge standard and percentage reduction in pollution across the plant. The mean standard in the EN12566 Part 3 certificate is a clear and unambiguous assessment of the performance of the plant.

Where a discharge requires sampling a numeric two-tier effluent quality standard is used to ensure that the discharge remains compliant and that downstream uses and water quality are not compromised. Limits are set as two-tier standards i.e. 95 percentile lower tier and a 99 percentile as upper tier, to enable compliance assessment[56].

Maintenance

Maintenance of the treatment facility should be in accordance with the manufacturer's instructions and a record of maintenance should be kept for inspection by SEPA. Septic tanks and primary settlement tanks should be desludged at a minimum frequency of once every two years[57]. If a package sewage treatment plant requires a power source the licence should include a condition requiring the provision of a visual or audible alarm system to notify of plant breakdown or power failure. Flow monitoring is not usually required for on-site wastewater treatment systems.

Water Reuse

The Waste Framework Directive establishes the legislation for the management of waste and sets the essential requirements for the management of waste, along with encouraging the application of the waste hierarchy to drive reuse and recycling.

5.2.2 Health Legislation and Considerations

Many properties in rural areas of Scotland are not connected to mains sewerage systems and therefore rely on onsite wastewater treatment systems. These systems can be a potential source of environmental contaminants and research suggests that the contribution from sewage discharges in rural areas from on-site wastewater treatment systems to total pollutant loadings can be as much as 10% and cumulatively they pose high risk to the quality of the receiving surface and ground waters[58]. Potential impacts on human health are a particular consideration

[55] *Regulatory Method (WAT-RM-04) Indirect Sewage Discharges to Groundwater DEC 2014*
[56] *Regulatory Method (WAT-RM-13) Microbiological Discharges*
[57] *Regulatory Method (WAT-RM-03) Sewage Discharges to Surface Waters*
[58] http://www.gov.scot/Resource/0040/00402151.pdf

in catchments where drinking water supplies, shellfish, and bathing waters are at risk from pollution from such sources.

In Scotland, phosphorus and faecal pathogen pollution are of particular concern. Phosphorus pollution can result in loss of environmental quality and amenity, while pathogen pollution can result in contamination of bathing waters and shellfish waters, increasing the risk of human exposure to pathogens. It is SEPA's responsibility to identify pressures and appropriate mitigation measures in order to ensure compliance with WFD and the Bathing Water Directive (2006/7/EC).

5.2.3 Economic Legislation and Considerations

The policies governing household water and wastewater charges are set by Scottish Ministers. These are published in a Principles of Charging statement which sets out how charges are to be calculated, any discounts and exemptions, and how they are to be collected. Household water and sewerage charges are determined by the Water Industry Commission for Scotland and are billed and collected by individual local authorities for Scottish Water, together with Council Tax. In 2016-17 the average household charge for water and sewerage services was £351[59].

During 2015-21, Scottish Water is investing £3.7 billion in its assets. The investment goes towards particular outputs to improve drinking water quality (£340M) and the environment with £115M on improving sewer Infrastructure and £174M on tackling wastewater discharges[60].

5.2.4 Conclusions

Scotland has a well-established and modern legislative and regulatory system for controlling wastewater treatment and discharges. Even systems ≤15pe need to be registered with SEPA for on-going review of maintenance of such systems. The evidence that cumulative outputs from a number of discharges pose an increased risk to the water environment and public health means a drive to promote alternative solutions in areas of increased risk, including consideration of community-based wastewater solutions is needed.

In Scotland the water industry contributes to the Scottish Government's Strategic Objectives of a wealthier and fairer Scotland through the national outcome of "our public services are high quality, continually improving, efficient and responsive to local people's needs". This along with the high number of on-site wastewater treatment plants <50pe public and private and the drive to ever increase environmental standards and quality of bathing / shellfish waters means INNOQUA is well placed to fill economic, environmental and social gaps.

[59] http://www.watercommission.co.uk/

[60] *https://www.scottishwater.co.uk/assets/about%20us/files/key%20publications/swdeliveryplan201521update2016.pdf*

5.3 Ireland

5.3.1 Environmental Legislation and Considerations

In Ireland, the requirements of the Directive 2000/60/EC of the European Council of 23 October 2000 establishing a framework for Community action in the field of water policy were transposed into Irish Law by the following Water Services Act 2007[61] and making of the following regulations: Waste Water Discharge (Authorisation) Regulations 2007 and (Amendment) Regulations 2010[62].

Waste Water Discharge

The Waste Water Discharge (WWD) regulations define the following with regards to waste water loadings.

Population equivalent is a measurement of organic biodegradable load. A population equivalent of 1 (1 p.e.) is the equivalent of having an organic biodegradable load of a five-day biochemical oxygen demand (BOD5) of 60g of oxygen per day; being the load calculated based on the maximum average weekly load entering the waste water works during the year, excluding unusual situations such as those due to heavy rain;

The regulations do not give any direction in terms of per capital hydraulic load (flow volume) and in terms of design a hydraulic load of 180 litres has been accepted as the p.e. equivalent (Environmental Protection Agency, 1999).

In Ireland, compliance with the EU Council Directive 91/271/EEC concerning urban waste water treatment (UWWT) is policed by the Environmental Protection Agency (EPA)[63]. For waste water treatment plants (WWTPs) bigger than 500 p.e. it must be licensed by EPA. Since the 1st of January of 2014, the responsibility for the supply of water to homes, businesses, the collection and treatment of municipal wastewater was transferred from local authorities to Irish Water, the new national water services authority. Funding for maintaining and improving the water supply infrastructure (pipes, filtration and disinfection systems) comes from the Department of Housing, Planning, Community and Local Government.

The EPA is an independent public body established under Ireland's Environmental Protection Agency Act, 1992. The other main instruments from which the authority derived its mandate are the Waste Management Act, 1996, the Protection of the Environment Act, 2003 and Radiological Protection (Miscellaneous Provisions) Act 2014. The EPA has a wide range of functions to protect the country's environment, and its primary responsibilities include:

- Environmental licensing

[61] http://www.irishstatutebook.ie/eli/2007/act/30/enacted/en/ *Water Services Act 2007 and Subsequent Amendments*

[62] http://www.irishstatutebook.ie/eli/2010/si/231/made/en/print *Waste Water Discharge (Authorisation) Regulation and Amendment Statutory Instrument No. 231 of 2010*

[63] https://www.epa.ie/

- Enforcement of environmental law
- Environmental planning, education and guidance
- Monitoring, analysing and reporting on the environment
- Regulating Ireland's greenhouse gas emissions
- Environmental research development
- Strategic environmental assessment
- Waste management
- Radiological protection

Where a plant operates under an EPA waste water discharge (WWD) licence, the Emission Limit Values (ELVs) or discharge limits of various parameters of the treated effluent arising from the plant are prescribed in the licence. These are likely to be more stringent than the requirements of the UWWT Directive and subsequent regulation. The parameters generally referenced in a WWD licence are;

- temperature
- pH
- carbonaceous biochemical oxygen demand
- suspended solids
- ammonia
- ortho-phosphate

Where a WWTP is not required to be fully licensed by the EPA, due to its size, it must operate under a waste water discharge certificate of authorisation (CoA) from the EPA and the limits listed in the UWWT Regulations, 2001[64] apply, see Table 17 below. Where effluent discharge is close to a sensitive or protected area as defined by the regulation, the ELVs defined by the licence are likely to be more stringent.

[64] http://www.irishstatutebook.ie/eli/2001/si/254/made/en/print *UWWT Regulations Statutory Instrument No. 254/2001*

Table 17: ELV UWWT Regulations 2001

Parameters	Concentration	Minimum % reduction[1]	Reference method of measurement
Biochemical oxygen demand 20°C without nitrification	25 mg O_2/l	70-90	Homogenised, unfiltered, un-decanted sample. Determination of dissolved oxygen before and after five-day incubation at 20° C ± 1° C, in complete darkness. Addition of a nitrification inhibitor.
Chemical oxygen demand	125 mg O_2/l	75	Homogenised, unfiltered, un-decanted sample Potassium dichromate
Total suspended solids	35 mg/l	90	Filtering of a representative sample through a 0.45 um filter membrane. Drying at 105°C and weighing

[1] Reduction in relation to the load of the influent

Testing of effluent samples for compliance with licence provisions in all cases is carried out at an external laboratory to samples collected on a monthly (or bi-monthly) basis from composite samplers at the sites. Continuous influent flow is generally measured by flowmeters downstream of preliminary treatment. These meters generally record a cumulative value for flow to full treatment at the plant and in many cases this value is recorded manually during inspection visits and the daily inflow computed.

Domestic Waste Water Treatment Systems (DWWTS) ≤ 10 p.e.

In Ireland, wastewaters from single houses that are not connected to sewers are generally treated on-site by septic tank systems or individual domestic wastewater treatment systems. There are estimated to be 440,000 wastewater treatment systems in Ireland[65].

Consent to build a DWWTS is given by a local authority as part of consent under planning regulations on submission of evidence that the site is suitable for the construction of such as system. Site suitability assessments (percolation tests) must be carried out in accordance with the 2009 EPA Code of Practice, Wastewater Treatment & Disposal Systems Serving Single Houses (p.e.<10). Environmental Protection Agency, 2009). The Site Suitability Assessment Report prepared from this assessment must be submitted in support of a planning application.

In recent years and following a European Court of Justice (ECJ) judgment made against Ireland in 2009[66] in relation to the management of domestic wastewater treatment systems, the Irish Government has introduced legislation to control the discharges from these systems.

[65] https://www.epa.ie/water/wastewater/legislation/

[66] http://curia.europa.eu/juris/liste.jsf?language=en&num=C-188/08 *ECJ judgment made against Ireland in 2009 in relation to the management of domestic wastewater treatment systems*

The legislation, the Water Services (Amendment) Act 2012[67], which was introduced by the Department of Environment, Community and Local Government aimed to allow the regulation of waste water discharges from all homes that are not connected to the public sewer network. Under the Act all septic tanks or domestic waste water treatment systems as defined must be registered and inspected:

A domestic waste water treatment system is any system involving physical, chemical, biological or thermal processes, or a combination of such processes, utilised for the treatment or disposal of domestic waste water, or the sludge derived from domestic waste water, and includes

a) all septic tanks and waste water tanks and systems receiving, storing, treating or disposing of domestic waste water and all drains associated with such tanks or systems, and
b) all drains associated with the discharge of domestic waste water, whether they discharge to a septic tank or waste water tank;

The register of domestic waste water treatment systems is maintained by the water services authority who will issue a certificate of registration for the system. A certificate of registration is valid for a period of 5 years from the date on which it was issued. The EPA is responsible for the National Inspection Plan: Domestic Waste Water Treatment Systems and inspections are carried out by local authority inspectors.

Design and Performance of DWWTS

The EPA Code of Practice for the Provision of Waste Water Treatment Systems for Single Houses (Environmental Protection Agency, 2010, 2012) require that all new domestic waste water treatment systems (including Septic Tanks) must now be tested in accordance with the requirements of EN 12566 and must satisfy the performance requirements as set out in the relevant National Annexes.

To ensure consistency across all types of domestic wastewater treatment systems (including septic tanks), a 2013 clarification to the EPA Code of Practice indicates that for packaged wastewater systems, the maximum p.e. should be defined by hydraulic load, this should be defined as 150 Litres and not 60g BOD/person load. The following are the current requirements for sizing of a DWWTS in Ireland.

The minimum house size is 2 bedrooms, which equates to a design capacity of 4 p.e. For every additional bedroom, irrespective of size, an additional 1 p.e. should be added as per the table below.

[67] *http://www.irishstatutebook.ie/eli/2012/act/2/enacted/en/print Water Services (Amendment) Act 2012*

Table 18: Design Requirements for DWWTS (EPA, 2013)

No. of Bedrooms	Design Population Equivalent
Min of 2	4
3	5
4	6
5	7
6	8
7	9
8	10

The Code of Practice defines minimum performance standards for DWWTS in Ireland and these are given in table below;

Table 19: On-Site DWWTS Minimum Performance Standards (EPA, 2012)

Parameter	Standard[1]	Comment
Biochemical oxygen demand (mg/l)	20	
Suspended solids (mg/l)	30	
NH4 as N (mg/l)	20	Unless otherwise specified by local authority
Total nitrogen[2] as N (mg/l)	5[3]	Only for nutrient-sensitive locations
Total phosphorus[2] (mg/l)	2[3]	Only for nutrient-sensitive locations

[1]95 percentile compliance is required for site monitoring carried out after installation.
[2]Only required to be achieved in nutrient-sensitive locations.
[3]24-h composite samples.

Operation & Maintenance of DWWTS

Following the establishment of the Water Services (Amendment) Act 1012, Regulation was introduced in relation to the operation and maintenance of DWWTSs. The Water Services Acts 2007 and 2012 (Domestic Waste Water Treatment Systems) Regulations 2012[68] outline the obligations of the owners of the treatment system to operate and maintain the system e.g. domestic waste water or sewage effluent shall not emit discharge, seep, leak or otherwise escape from the system other than as intended by design. The regulations further require that owners de-sludge the system at intervals appropriate to the tank size and that such de-sludging shall be carried out by an authorised contractor[69] and contents disposed of in accordance with all relevant national legislative requirements or directions pertaining at the time.

Re-use

The 2012 regulations allow the owner of a domestic waste water treatment system the possibility of de-sludging of that system and use its contents in agriculture, subject to compliance with all relevant national legislative requirements or directions pertinent at the time. Such regulations are the Waste Management (Use of Sewage Sludge in Agriculture) Regulations 1998[70] and its Amendment Regulations and the European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2010 (S.I. No. 610 of 2010).

The regulations dictate that except in the situations outlined below, only treated sludge i.e. sludge which has undergone biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use; may be used in agriculture.

Untreated sludge may be used in agriculture provided that it is previously injected or otherwise worked into land also residual sludge from septic tanks may be used on grassland provided that the grassland is not grazed within six months following such use (residual sludge is sludge from sewage plants treating domestic or urban waste waters and from other sewage plants treating waste waters of a composition similar to domestic and urban waste waters, e.g. that from septic tanks and other similar installations for the treatment of sewage and from sewage plants.

5.3.2 Health Legislation and Considerations

The EPA estimate that there are 440,000 DWWTs in Ireland currently, representing 440,000 houses that are not connected to a sewer system. Based on current population of the state of 4.76 million (Central Statistics Office[71], 2016) and a household average size of 3.4 (Central Statistics Office, 2012) this represents 31% of the population.

[68] http://www.irishstatutebook.ie/eli/2012/si/223/made/en/print *S.I. No. 223/2012 - Water Services Act Regulations*

[69] http://www.irishstatutebook.ie/eli/2007/si/820/made/en/print?q=820 *S.I. No. 820 of 2007 Waste Management (Collection Permit) Regulations 2007 (S.I. No. 820 of 2007) and amendments 2008*

[70] http://www.irishstatutebook.ie/eli/1998/si/148/made/en/print?num=148&years=1998&search_type=si *Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998 and amendments 2001*

[71] *Central Statistics Office Preliminary Results from 2016 census*

A 2014 report from the EPA on Urban Waste Water Treatment (EPA, 2015) presents the level of waste water treatment provided during 2014 for the main (primary) waste water discharge from each of the 510 urban areas subject to the WWD licensing programme, i.e. areas with a p.e. of 500 or more. The findings are presented in Table 20 and Table 21 below.

Table 20: Summary of the level of waste water treatment provided in 2014 (areas ≥ 500 p.e.)

Number of areas with no Preliminary Treatment	Number of areas with Primary Treatment	Number of areas with Secondary Treatment	Number of areas with Secondary Treatment and nutrient Removal	Total
35	49	206	220	510

Table 21: Waste Water Treatment Provided for national load (areas ≥ 500 p.e.) by p.e

No Treatment or Preliminary Treatment (%)	Primary Treatment (%)	Secondary Treatment (%)	Secondary Treatment and nutrient Removal (%)
4.6	1.2	68.6	25.7

As the policing body, the EPA must be informed of all incidents at areas with a waste water discharge authorisation; An incident is any discharge that does not comply with the requirements of a waste water discharge licence or any occurrence at a waste water works with the potential for environmental contamination or requiring an emergency response by the authorisation holder and/or relevant authorities.

The 2014 EPA UWWT Report details that 1,294 notifications of incidents were received in 2014. These incidents were at 256 licensed waste water works and 24 waste water works with a certificate of authorisation. 72% of reported incidents relate to effluent discharges that licensee self-monitoring demonstrated did not meet the relevant quality standards. The remainder were mostly overflows or uncontrolled releases. 42% of incidents are attributed to insufficient treatment capacity, up from 35% in 2013.

85% of incidents were reported as minor (e.g. deviations from licence requirements with no contamination / localised effects) and 15% (200) were reported as simple contamination. Over two thirds of the simple contamination incidents were closed at the time of publication of the report. The remainder are associated with discharges from 18 urban areas and most of these areas require infrastructure improvements to address the root cause of the incidents.

5.3.3 Economic Legislation and Considerations

Domestic water charges were introduced in 2015 for homes that are connected to a public water supply or to public wastewater services. Irish Water, the national water utility, is charged with

administering the water charges. Following a period of public objection, the domestic water charges have now been suspended. The Water Services (Amendment) Act 2016 that became law in July 2016 has:

- Suspended domestic water charges for 9 months, from 1 July 2016 to 31 March 2017, with no charging or billing of domestic customers during that period;
- Suspended issuing of domestic water bills for the second quarter of 2016, which had been due to issue in the third quarter of 2016.

An expert commission has been established to make recommendations on a sustainable long-term funding model for domestic water and wastewater services.

Proposed Domestic Charges

For households using the public water supply and the public wastewater service, a metered rate of €3.70 per 1,000 litres was proposed by Irish Water. If a household only uses 1 public water service - supply or wastewater services, a rate of €1.85 per 1,000 litres was proposed.

The charging strategy originally proposed by Irish Water included capped charges as follows to limit the charges to households; usage of just over 43,000 litres per year for a single-adult household and just over 70,000 litres per year for a multi-adult household. These proposals together with a free allowance to cover each child's normal water/wastewater needs (21,000 litres per child) would have resulted in the following sample charges for households.

Table 22: Sample capped charges for households using both Water Services (Irish Water Charging Proposals, 2015)

People in Household	Maximum Annual charge*	Maximum Quarterly Bill	Annual Water Conservation Grant
1 adult, with or without children	€160	€40	€100
2 adults, with or without children	€260	€65	€100
More than 2 adults, with or without children	€260	€65	€100

*50% for waste water disposal only

Commercial Charges

Commercial Water Charges vary from local authority area, they include a standing charge and a usage charge. The table below gives details of such charges for a sample area.

Table 23: Sample Commercial Water Charges

Charge	Euro	
	Galway County Council	Dublin City Council
Min standing charge per annum (dependant on size of supply pipe/meter)	88	151
Max standing charge per annum (dependant on size of supply pipe/meter)	528	1,512
Water Supply m^3:	1.19	1.16
Wastewater Services m^3:	1.26	0.83
Combined m^3:	2.45	1.99

Investment

On 1 January 2014, Irish Water assumed responsibility for water and wastewater services to homes and businesses in Ireland connected to a public water supply. Irish Water is the national water utility responsible for providing and developing water services throughout Ireland. It brings the water and wastewater services of the 31 local authorities together under one national service provider.

In May 2014, Irish Water published its Proposed Capital Investment Plan 2014-2016 (Irish Water, 2014) that indicated €1.77 billion was needed to meet the objectives identified by Irish Water and previous programmes of the Department of the Environment, Community and Local Government.

In terms of spend, the table below outlines the proposed capital investment in Water and Waste Water for the period 2014-2016.

Table 24: Proposed Capital Investment Plan Summary 2014-2016 (Irish Water, 2014)

Category	2014-2016 Projected Spend
Major Capital - Main Driver Drinking Water Quality	€193,506,625
Major Capital - Water Conservation	€151,997,184
Major Capital - Main Driver Drinking Water Availability	€136,845,135
Water Total	**€482,348,944**
Major Capital - Main Driver Wastewater Compliance	€366,206,779

Major Capital - Main Driver Wastewater Availability	€379,896,879
Wastewater Total	**€746,103,658**
Minor Capital Works (Reactive), Minor Capital Projects etc	€1,025,313,584
Grand Total	**€1,771,417,242**

Pre-2014, the water services were run by the local authorities in Ireland, costs and the contribution to capital investment are published annually in a combined statement. Figure 7: Expenditure in Ireland on Water & Waste Water 2009 - 2013Figure 7 below indicates the combined expenditure for the local authorities on water and waste water in the 5 years prior to the establishment of Irish Water.

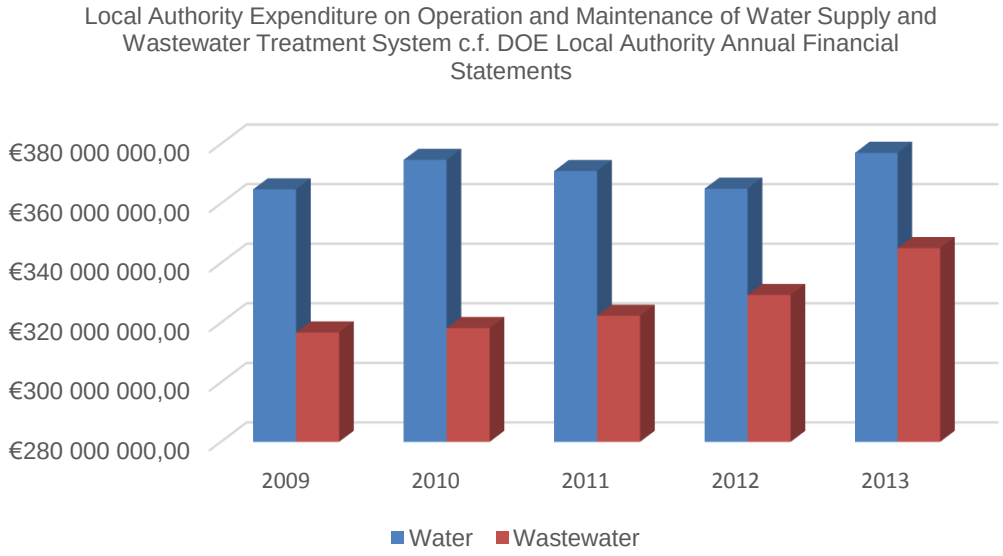

Figure 7: Expenditure in Ireland on Water & Waste Water 2009 - 2013[72]

5.3.4 Conclusions

Ireland has a well-developed legislative and regulatory system for monitoring the treatment of waste water and discharge of treated effluent. Outside of larger settlements there is a very high dependence on DWWTs for both individual houses and small settlements where connection to a public sewer is not available due to the dispersed nature of rural communities.

[72] *In Ireland, Each local authority is required to prepare an Annual Financial Statement (AFS) by the end of March following the year end and to publish it by the end of June* http://www.housing.gov.ie/search/archived/archived/archived/current/type/publications?query=Local%20Authority%20Financial%20Statement

There is little guidance and regulation regarding the reuse of treated waste water in Ireland and where it does exist is limited to the re-use of slurry and treated sludge for agricultural purposes. Given the relative size of the agricultural industry in Ireland, its requirement for water and the significance of slurry storage and management to the industry, the INNOQUA project is well placed to make a positive contribution.

5.4 France

5.4.1 Environmental Legislation and Considerations

French legislation in terms of non-collective sanitation is subdivided according to the capacity of each system (in terms of Person Equivalent). French government set a Person Equivalent equal to influent loading of Biodegradable matter corresponding to a BOD5 equivalent to 60 grams per day[73]. This load corresponds to a quantity of 150 Litres per day and per person.
Basically regarding the market target of Innoqua project it is possible to consider French on site sanitation systems regulation to be divided, with in the first hand laws for less than 1,2kg of BOD5 per day and in the other above 1,2kg of BOD5 per day.

French regulation stipulates that on-site sanitation system with a capacity lower than 20 P.E. corresponding to an influent loading under 1,2kg DOB5 per day have to respect the ruling of March 7th 2012[74] amending the ruling of September 7th 2009[75]. The text explains obligations of such systems to respect effluent quality according parameters. For a capacity above 1,2kg DOB5 systems are under the ruling of the June 22th 2007[76].

Authorisation & Installation

France Municipalities have the jurisdiction in terms of collective or non-collective sanitation with the article L2224-8 of the French General Territorial Public Entities Code[77].
The French Environmental Code through the Article L214-2[78] explains the obligation to study the necessity or not to complete a form of authorisation or a declaration according to the volume of discharged wastewater into the natural environment with the following parameters:

- Obligation to achieve a demand of declaration if the amount of BOD5 is above 12kg per day but above 600 kg per day.
- Obligation to achieve a demand of authorisation if the amount of BOD5 is above 600kg per day.

Below a quantity of 12kg of BOD5 per day neither declaration nor authorisation is needed.

[73] *Code général des collectivités territoriales, Article R2224-6, May 4th, 2006*
[74] *Journal officiel du gouvernement n°0098, April 25th 2012*
[75] *Journal officiel du gouvernement n°0234, October 9th 2009*
[76] *Arrêté du 22 juin 2007*
[77] *Code général des collectivités territoriales, Article L2224-8, July 14th 2014*
[78] *Code de l'environnement Article L214-2, July 19th, 2015*

Building permit

In the case of the resale of a building which is non-connected to the general sewage system the seller must provide proof of control of the system within the three years before the transaction, as mentioned into the French building code[79]. This sus-mentioned control is ensured by the Municipalities (through the Non-collective sanitation Utilities, called *SPANC* in French*)* following dispositions of the Article L1331-1-1 from the French Public Health Code[80].

An on-site sanitation system must be implanted at a minimal distance of 35 meters from any private water pumping, respect the minimal distance with the public water pumping according to local regulation and a minimal distance from any limits of the private plot of 3 meters and this in accordance with the article R 111-18 of the French Urbanism Code[81].

Since March 1st 2012 and in application of the Article R 431-16[82] from the French Urbanism code, every demand of building permit for non-connected building to the general sewage system must present a certificate of conformity for the sanitation system. This document is mentioned as «*Cerfa n° 13409*02 Récépissé de dépôt d'une demande de permis de construire ou de permis d'aménager».*

Zoning

Municipalities must define, trough non-collective sanitation utilities (called SPANC), a zoning of their territory. This zoning presents areas where the density of habitants is dense enough to provide collective sanitation at a lower cost, and where this density does not allow collective sanitation and where on-site sanitation system are favoured. This obligation was introduced by the Water Law in January 3th 1992.

Environmental priory areas must be respected following the Article R2224-13 of the French General Territorial Public Entities Code. This article stipulates that Environmental priory areas must be defined by the "*Schéma Directeur d'Aménagement et de Gestion des Eaux*" and/or "*Schéma d'Aménagement et de Gestion des Eaux*" set up by the Regional Water Agencies. The first document is revised every six years by elected representatives from different colleges.

The Decree of January 25th, 2010[83] defines standards to assess the ecological status for the different types of water bodies such as rivers, lakes and closed water bodies, transitional waters (like estuaries), coastal waters and artificial or heavily modified water bodies. The assessment is based on 3 groups of parameters: biological parameters, physicochemical parameters and specific pollutants. For each parameters and each type of water bodies, the Decree sets maximum, minimum or gap limits values.

If these documents do not present environmental priority areas, the promoter can refer to the sources of information present in the Table 25.

[79] *Code de la construction et de l'habitation, Article L271-4, June 8th 2006*
[80] *Code de la Santé Publique, Article L1331-1-1, December 30th 2006*
[81] *Code l'Urbanisme Article R 111-18, January 7th 2007*
[82] *Code de l'urbanisme, Article R431-16, March 1st 2012*
[83] Code de l'environnement, Article R2224-13, Janury 25th , 2010

Table 25: Sources of information for the delimitation of environmental priory areas

Information	Sources	Utilities resources
Protected area of pumping for drinkable water	Ruling of Prefecture Region	Regional Health Agency Municipality
Sensitive are such as: pumping of drinkable water, bathing water, nautical activities, fish farm…	Ruling of Prefecture Inventory of Bathing water http://baignades.sante.gouv.fr/	Prefecture Regional Health Agency Regional service of Minster
SDAGE / SAGE	Inventory: http://gesteau.eaufrance.fr	Water Agencies
Acronyms: SDAGE (Schéma Directeur d'Aménagement et de Gestion des Eaux), SAGE (Schéma d'Aménagement et de Gestion des Eaux)		

Scaling of the system

Scaling of the system is conducted by the ruling of the March 7th 2012 and according to R 111-1-1 and R 111-10 where in case of an individual housing the following ratio is apply:

PR=PE

And where PR corresponds to principal room's amount and PE person equivalent. PR is defined by the following rule: a room for which the occupation is sleeping, living. At the opposite services rooms like bathroom, kitchen, storeroom, laundry, and kiln are not considered as Principal Rooms.

For public buildings and tertiary buildings (individual housings include) which received a disproportioned number of inhabitants compared to the living surface the calculation can be done according to the expected real consumption where 1 PE = 150 Liters.

Effluent quality

Regarding the capacity of each system the effluent quality must respect regulations. Table 26 represents the expected minimal quality of effluents for a system corresponding to a maximum of 20 PE (1,2 of BOD5 per day). Then Table 27 corresponds to effluent quality of systems with a capacity above 20 PE but below 2 000 PE (120 kg of BOD5 per day). For this second category the pH must be comprised between 6 and 8.5 and the water temperature mustn't exceed 25°C.

Table 26: Minimal performances of systems which have a capacity below 1,2kg of DBO5 per day[84].

Parameters	Thresholds	Reference methods
BOD5 concentration (g BOD5/Liter)	35	NF ISO 5815
Suspended Solid (solid matter) (mg.l)	30	NF EN 872

[84] *Journal officiel du gouvernement n°0234, October 9th 2009*

Table 27: Minimal performances of systems which have a capacity above 1,2kg of DBO5 per day but below 120 kg[85].

Parameters	Thresholds	Minimum yield	Reference methods
BOD5 concentration (g BOD5/Litre)	35	60%	NF ISO 5815
COD (g COD/litre)	-	60%	NF ISO 6060
Suspended Solid (solid matter) (mg.l)	-	50%	NF EN 872

In case of discharge into a natural receptor, such as rivers or lakes, which are sensitive to eutrophication, the threshold for effluent quality can be more ambitious according to local regulation.

The Article 8 and 9 of the Decree of July 21th, 2015 on collective sanitation systems and on-site sanitation facilities (excepting of individual sewerage systems receiving a gross load of organic pollution less than or equal to 1.2 kg BOD5/d (2000 p.e.) indicates that the treated wastewater is preferably discharged into surface water or reused in accordance with the regulations and in case in case of reuse of treated wastewater should be demonstrated the compliance with the current regulation.

The Circular September 29th, 2010[86] specifies the modalities of setting up a monitoring for the presence of certain micro-pollutants (e.g. pesticides, COHV, metals…) in water discharged into the environment through wastewater treatment plants.

Reuse of wastewater

Reuse of urban wastewater is framed by the ruling of the September 2sd 2016[87] for systems with a capacity above 1,2kg of BOD5. The ruling set up a frame for the likely reuse of wastewater specifically for irrigation of crops or green space. For a system with a capacity below 1,2kg of BOD5 the reuse of water is possible on plots except for irrigation for edible vegetables. The sub mentioned legal text “the reuse of waters stemming from an urban WWTP for irrigation of agricultural crops or green space” establish four levels of quality, restrictions on uses, distances, land slope and origin of treated wastewater, includes monitoring requirements (at WWTP and on irrigated land) and information requirements, establishes the process to apply for a water reuse permit. The Decree establish 11 potential uses for the wastewater (see

[85] *Arrêté du 22 juin 2007*

[86] *http://www.ineris.fr/aida/consultation_document/7003*

[87] *Arrêté du 26 septembre 2016 relatif à l'utilisation d'eaux issues du traitement d'épuration des eaux résiduaires urbaines pour l'irrigation de cultures ou d'espaces verts.*

Table 28) which are: (i) food crops intended for human consumption, consumed raw; (ii) food crops intended for human consumption subject to thermal process; (iii) grassland; (iv) recreational areas (e.g. golf courses, forests open to public); (v) flowers sold cut; (vi) other flowers; (vii) nursery and shrub; (viii) fodder crops; (ix) other cereal crops; (x) fruit production; and (xi) forest exploitation with limited public access. Nevertheless, there are some restrictions for their used such as: (i) irrigation with raw sewage; (ii) irrigation with treated wastewater from WWTPs connected to certain animal by products processing installations; (iii) irrigation with treated wastewater from WWTPs whose sewage sludge do not comply with limit values specified by the French legislation on agricultural use of sewage sludge; (iv) irrigation with treated wastewater on soils that do not comply with limit values specified by the French legislation on agricultural use of sewage sludge; and (v) irrigation with treated wastewater within the close protection perimeters of drinking water abstraction points (with some exceptions).

Table 28: Use categories and required water quality (source: Decree of August 2nd, 2010)

TYPE D'USAGE	NIVEAU DE QUALITÉ SANITAIRE DES EAUX USÉES TRAITÉES			
	A	B	C	D
Cultures maraîchères, fruitières et légumières non transformées par un traitement thermique industriel adapté (excepté cressiculture (1)	+	-	-	-
Cultures maraîchères, fruitières, légumières transformées par un traitement thermique industriel adapté	+	+	-	-
Pâturage (2)	+	+ (3)	-	-
Espaces verts ouverts au public (4)	+ (5)	-	-	-
Fleurs vendues coupées	+	+ (6)	-	-
Pépinières et arbustes et autres cultures florales	+	+	+ (6)	-
Fourrage frais	+	+ (3)	-	-
Autres cultures céréalières et fourragères	+	+	+ (6)	-
Arboriculture fruitière	+	+ (7)	+ (8)	-
Taillis à courte rotation ou à très courte rotation, avec accès contrôlé du public	+	+	+ (6)	+ (6)
Forêt, hors taillis à courte rotation avec accès contrôlé du public	-	-	-	-

+ autorisée, - : interdite.
(1) La réutilisation d'eaux usées traitées est interdite pour la cressiculture.
(2) En cas d'aspersion, les animaux ne doivent pas être au champ au moment de l'opération et les abreuvoirs, au cas où ils seraient arrosés, doivent être rincés avant utilisation.
(3) Sous réserve du respect d'un délai après irrigation de 10 jours en l'absence d'abattoir relié à la station de traitement des eaux usées et de 21 jours dans le cas contraire.
(4) On entend par espace vert, notamment : les aires d'autoroutes, cimetières, golfs, hippodromes, parcs, jardins publics, parties communes de lotissements, ronds-points et autres terre-pleins, squares, stades, etc.
(5) Irrigation en dehors des heures d'ouverture au public, ou fermeture aux usagers pendant l'irrigation et deux heures suivant l'irrigation dans le cas d'espaces verts fermés ; irrigation pendant les heures de plus faible fréquentation et interdiction d'accès aux passants pendant l'irrigation et deux heures suivant l'irrigation dans le cas d'espaces verts ouverts de façon permanente.
(6) Uniquement par irrigation localisée, telle que définie à l'article 2.
(7) Interdite pendant la période allant de la floraison à la cueillette pour les fruits non transformés, sauf en cas d'irrigation au goutte à goutte.
(8) Uniquement par goutte à goutte.

Decree also defines 4 required water quality levels (A, B, C and D) for each use category, each with specific numerical limit values for a range of parameters (see Table 29). The reclaimed water should to fulfil some parameters which are: (i) suspended solids; (ii) chemical oxygen demand; (iii) faecal coliforms; (iv) F-specific bacteriophages; (v) spores of sulphate-reducing anaerobic bacteria; and (vi) E.coli. It is important to note a particularity of the French approach, the monitoring programme to be put in place partly relies on the monitoring of sewage sludge quality and agricultural soils, in accordance with the French legislation on the agricultural use of sewage sludge. Sewage sludge quality is indeed considered to be a reliable indicator of the overall WWTP efficiency with regard to the removal of pathogens and other hazardous substances.

Table 29: Health quality levels of treated wastewater for reuse (source: Decree of August 2nd, 2010)

PARAMÈTRES	NIVEAU DE QUALITÉ SANITAIRE DES EAUX USÉES TRAITÉES			
	A	B	C	D
Matières en suspension (mg/L)	< 15	Conforme à la réglementation des rejets d'eaux usées traitées pour l'exutoire de la station hors période d'irrigation		
Demande chimique en oxygène (mg/L)	< 60			
Escherichia coli (UFC/100mL)	≤ 250	≤ 10 000	≤ 100 000	-
Entérocoques fécaux (abattement en log)	≥ 4	≥ 3	≥ 2	≥ 2
Phages ARN F-spécifiques (abattement en log)	≥ 4	≥ 3	≥ 2	≥ 2
Spores de bactéries anaérobies sulfito-réductrices (abattement en log)	≥ 4	≥ 3	≥ 2	≥ 2

The same Decree also defines the distance restrictions between the WWTP and water bodies. Table 30 summarised these restrictions for each water bodies and category.

Table 30: Distance constraints

NATURE DES ACTIVITÉS À PROTÉGER	NIVEAU DE QUALITÉ SANITAIRE DES EAUX USÉES TRAITÉES		
	A	B	C et D
Plan d'eau (1)	20 m	50 m	100 m
Bassin aquacole (à l'exception des coquillages filtreurs) Pisciculture y compris pêche de loisir	20 m	50 m	100 m
Conchyliculture Pêche à pied des coquillages filtreurs	50 m	200 m	300 m
Baignades et activités nautiques	50 m	100 m	200 m
Abreuvement du bétail	50 m	100 m	200 m
Cressiculture	50 m	200 m	300 m
(1) A l'exception du plan d'eau servant d'exutoire au rejet de la station de traitement des eaux usées et des plans d'eau privés où l'accès est réglementé et où aucune activité telle que baignade, sport nautique et aquatique, pêche ou abreuvement du bétail n'est pratiquée.			

Also, the Decree 94-469 of June 3rd, 1994[88] concerning wastewater collection and treatment specifies in the Article 24 that the treated wastewater can be used for agronomic or agricultural purposes, for watering or for irrigation, provided that their characteristics and their methods of use are compatible with the requirements of protection of the public health and the environment.

Control

Additionally, the France legislation requires to the WWTP operator is in charge of implementing a monitoring programme including: (i) sampling and analysis of E. Coli according to a specific schedule; (ii) annual monitoring of all parameters; (iii) monitoring of the quality of sewage sludge produced by the WWTP (at least 4 times/year). Moreover, the WWTP operator shall communicate the monitoring results and exceeded parameters to the Préfet, the mayors concerned and the users of irrigated land. Additionally, at least every 10 years, the user of irrigated land shall perform an analysis of soil samples targeting the trace elements covered by the French legislation on the agricultural use of sewage sludge and communicated to the WWTP operator. Finally, the irrigated plot managers have to maintain a register with indications of crop location and type, volumes of reused water, the time during which crops are irrigated with reused water and the results of the monitoring programme (on reclaimed water, sludge and soils) in order to maintain the traceability measures. Municipalities must control the onsite sanitation quality system, once at the installation, and at least every ten years for systems which have a capacity below 1,2kg/day of BOD5[89]. These controls are performed by the non-collective sanitation Utilities (*SPANC).*

Regarding the systems able to treat more than 1,2kg of BOD5 per day, controls must comply with the frequency presented in *Table 31*.

Table 31: Minimal frequency of control for systems which a capacity superior at 1,2kg/day of BOD5[90].

Capacity of the system kg/d of BOD5	Below 30	Above and equal to 30 and below 60	Above 60 and below 200
Number of control	Once every two years	Once a year	Twice per year

Agreement of systems

Non-collective wastewater treatment systems must obtain a certification by the French Minister of Health and Ecology, by demonstrating the efficiency of the system and provide an evaluation of the health risks of the system. This certification is compulsory for system for 20 PE and less (1,2 kg BOD5 per day). Two processes are distinguished:

[88] https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=LEGITEXT000005615953
[89] Loi n° 2010-788 du 12 juillet 2010
[90] Arrêté du 22 juin 2007

- A process based on the measurement on an experimental platform for a 15 months survey.
- A simplified process based on the analyses of measurements provided by the supplier for the systems which present the CE marking, or for system which is commercialised for more than 3 months. This process can lead to an agreement without any additional testing for systems presenting CE marking, and which respect the quality of the effluent following the article 27 of the Law named "Grenelle 1"[91]. The quality of effluent considered has to correspond to a conformity rate of 100%.

To all situations to obtain this certification, systems must respect:

- Sanitation efficiency with an effluent quality below 30mg/L for the Solid Suspended matter and below 35 mg/L for the BOD5.
- Principles of the ruling of September 7th 2009[92].
- Technical specifications presented: reference document (NF DTU 64.1, série NF EN 12566 and requirements of the regulation n° 305/2011 of the European Parliament and of the Council of the March 9th 2011) establishing the framework for harmonised conditions of commercialisation for building products.

This evaluation is performed by a body such as CERIB (*Centre d'Etudes et de Recherches de l'Industrie Béton*) and CSTB (*Centre scientifique et Technique du Bâtiment*), mentioned in the article 9 of the July 8th 1992.
A listing of granted systems is published in the French Official Journal and is retrievable on the Minster online platform[93] as well as the whole procedure details[94].

Greenhouses gases Emission
Wastewater treatment works can represent a large part of greenhouses gases emission through the functioning of sewage treatment plants, its energy consumption, transportation and treatment of waste. ADEME (French Environment and energy National Agency) estimated sewage treatment plants to be responsible of 20% of greenhouses gases emissions of the municipalities scale in 2008.

5.4.2 Health Legislation and Considerations

Despite a relative good wastewater treatment 18,8% (5 million of housings) of the French population is not connected to a general sewage system[95]. This proportion includes the 2% of

[91] Grenelle 1
[92] Journal officiel du gouvernement n°0234, October 9th 2009
[93] http://www.assainissement-non-collectif.developpement-durable.gouv.fr/les-filtres-compacts-agrees-a645.html
[94] http://www.assainissement-non-collectif.developpement-durable.gouv.fr/IMG/pdf/V13_14_03_2014_cle51fc3c.pdf
[95] Eurostat, 2016

the population who doesn't benefit of any sanitation system. This proportion of non-connected housings to general sewage system was 17% in 2008, 19% in 2004 and 32% in 1998[96].
These proportions are not uniform on the entire territory, in fact overseas French territories such as Guadeloupe, Guyana and Mayotte present a rate of connected housing much higher than the national average with respectively 21%, 30% and 60% of non-connected housings neither to general sewage system nor to on site sanitation system. As showed in the Figure 8Figure 8, this percentage of non-connected housing is non homogeneous at the national scale.
Housings possessing on site sanitation systems are mainly located in rural area where collective system are difficult and expensive to install.

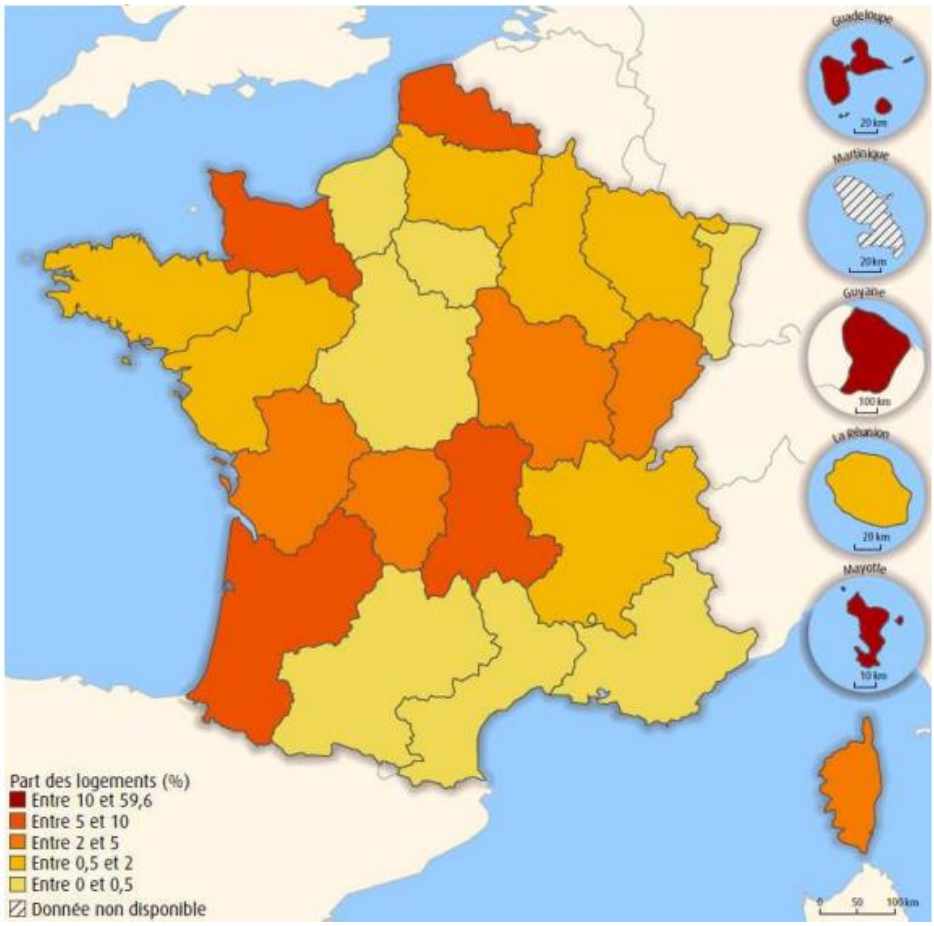

Figure 8: Representation of percentage of non-connected housings to any sanitation system nor collective or on site sanitation system (legend: Percentage of housings between 10 and 59,6%, between 5 and 10, between 2 and 5, between 0,5 and 2, between 0 and 0,5, unavailable data). Source: SOeS-SSP, survey « eau-assainissement », 2008.

Reuse of water is a worldwide issue, every day 20 million m^3 of water are reused. Several European countries have developed large projects for water reuse especially Spain and Italy

[96] *SOeS-SSP, enquête « eau-assainissement »,2008*

with a reuse of water of 350 million m^3 and 240 million m^3 per year respectively. While France reuses 7,7million m^3 per year.[97]

Reuse of treated wastewater is possible according to Health regulations. For systems with a capacity above 1,2kg of BOD5 they are framed by the ruling of the September 26th 2016. The ruling set up a frame for the likely reuse of wastewater specifically for irrigation of crops or green space. For a system with a capacity below 1,2kg of BOD5 the reuse of water is possible on the plot at the exception of irrigation of edible vegetables. Moreover ANSES the National Agency of health security, for food, environment and work published in 2012 a National Advice regarding the health risks of wastewater reuse[98] in the two main following cases:

- Reuse by spraying for irrigation of green spaces and risks for respiratory tracts and cutaneous.
- Reuse of wastewater for road cleanings.

Main conclusions of the study are the high likely absence of health risks regarding the reuse of wastewater for irrigation of green spaces and lack of data concerning the risks according to reuse of water for road cleanings.

The Decree of January 11th, 2007[99] defines the limits and quality references to raw water intended for human consumption including microbiological, chemical, organoleptic and radioactive parameters.

On the other hand, the Decree of January 21st, 2010[100] defines program of samplings and health control analyses for waters supplied by the distribution network. It stablishes the different analysis to be performed in the water depending of the extraction point (raw water, distribution point and taps normally used by the consumer) and the analysis type (water from surface, water from groundwater, routine analysis of the distribution program carried-on point and additional analysis).

In 2012, the French Sanitary Agency (ANSES)[101] conducted a study aiming at assessing health risks from the reuse of water using spray irrigation (for crops and green spaces) and for street cleaning. This study aimed at providing recommendations as part of a possible revision of the "Ministerial Order August 2010". The ANSES suggested replacing the experimental study required by Article 4 by requirements on treatment levels and risk management measures (spraying at night, setback distances, etc.). With regard to water reuse for street cleaning, the ANSES considered that insufficient exposure data was available to assess potential risks for workers and pedestrians and recommended that exposure surveys be carried out.

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[97] *Mediterranean Wastewater Reuse Report, EU Water initiative, 2007 (EUWI)*

[98] *ANSES, la réutilisation des eaux usées traitées pour l'irrigation des cultures, l'arrosage des espaces verts par aspersion et le lavage des voiries, Saisine n° 2009-SA-0329, 2012*

[99] https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000465574

[100] https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000021923970&dateTexte=&categorieLien=id

[101] *ANSES, la réutilisation des eaux usées traitées pour l'irrigation des cultures, l'arrosage des espaces verts par aspersion et le lavage des voiries, Saisine n° 2009-SA-0329, 2012*

A methodology for assessing the technical and economic feasibility of treated wastewater reuse was developed by ISPRA (Institute for Environmental Protection and Research) in 2012. [102]

5.4.3 Economic Legislation and Considerations

Cost of wastewater treatment is 1,82 €/m^3 in France[103]. This cost is not uniform on the entire territory, 20% of the French population deviation to the average is over 0,56 €/ m^3. 80% of the French population benefit of a price of sanitation between 1,22€/m^3 and 2,53€/ m^3. It is important to mention that cost of wastewater treatment represents 39% of the total amount of the cost of water with 39% for drinkable water and 22% for taxes and fees.

The Six French National Water Agencies are the main organisations in terms of favouring the setup of sanitation system on the territory. Aim of these Agencies is to setup guiding document on the water policy such as the "*Schéma Directeur d'Aménagement et de Gestion des Eaux".* This document is a reference document guiding policies at the scale of the territory of each Water Agency according to the Water Framework Directive and its regional application. All six agencies have an initial budget of 13,3 billion euros for the tenth intervention program from 2013 to 2018. This program is updated every six years by the elected member of each Water Agency Bassin Committee which is considered as the water parliament. 800 million € will be dedicated during this tenth program to support individual work in terms of sanitation in sensible areas. In the previous Intervention program (2009-2012) 55% of the budget was dedicated to sanitation projects. Non-collective sanitation will be more and more funded by the Water Agencies due to of new regulations and disrepair of systems, see Figure 9Figure 9. But it is also lead by the fact that a sewage network costs three time more than the cost of a sewage treatment plant (Every euros spent for sewage treatment plant need 3 euros for the network)

[102] *http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/modello-di-indagine-per-la-valutazione-della-fattibilita-del-riuso-delle-acque-reflue-depurate).*

[103] *Rapport national des données sispea – synthèse, September 2014*

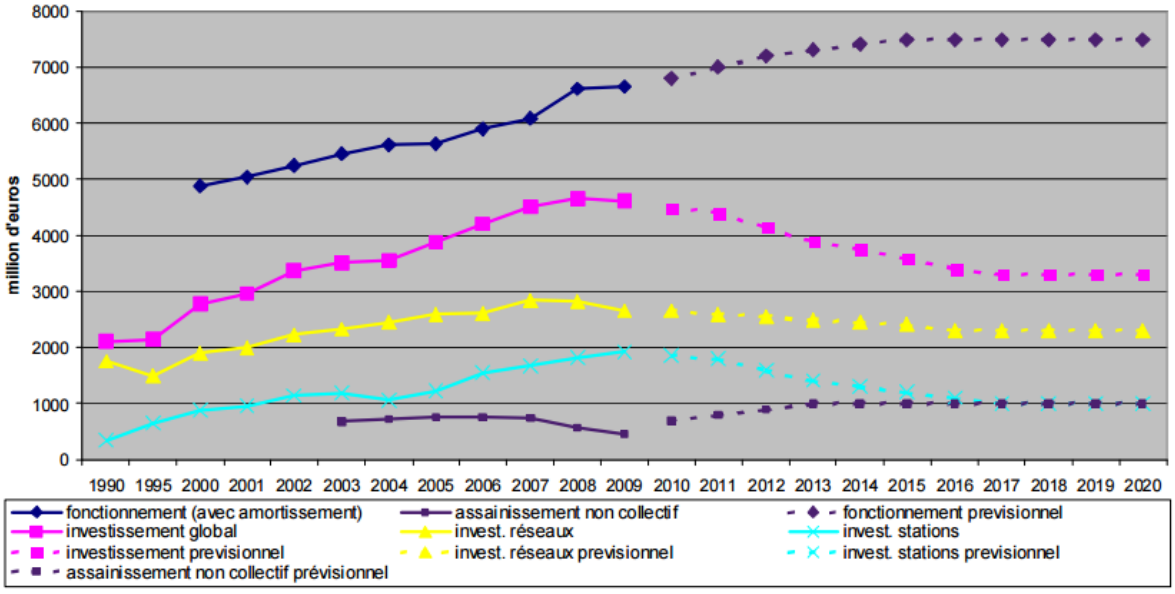

Figure 9: Spending of sanitation in France from 1990 to today and expectations to 2020 with from top to down costs for functioning with amortisation (blue squares), global investment (pink squares), costs of network (yellow triangles), cost of sewage treatment plant construction (blue cross) and cost for non-collective systems (mauve square). Source: SOeS-SSP, survey « eau-assainissement », 2008.

Installation of onsite sanitation system comprises between 5 000€ and 15 000€ according to the 2014-2019 National Plan of actions of non-collective sanitation of French Ministries[104]. This National Plan wants to affirm non-collective sanitation technic as a relevant alternative with good efficiency. Furthermore the National Plan defends the economic value of non-collective sanitation and wants work in a long term perspective in order to include these technics into a sustainable development strategy.

5.4.1 Conclusions

France presents strong standards and regulations on wastewater, reuse of water and health. These standards provide a good framework to the implementation of Innoqua project in the territory and will allow development of a strong adaptation of the technology to reply to the policies constraints. Water stress increases day after day and although France doesn't know shortage of water yet, policies are considering climate change and anticipate these as likely issues, providing regulations which offer an appropriate space for the Innoqua development.

[104] *Plan d'actions national de l'assainissement non collectif 2014-2019, October 2014*

5.5 Italy

5.5.1 Environmental Legislation and Considerations

The reference document to treat urban and industrial wastewater in Italy is the “Decree of Environmental Ministry 185/2003”[105] which is a very restrictive standard (certain quality standards are similar to those for drinking water) with a high number of parameters to be monitored (>50). Moreover, it is important to note that under this regulation, an authorisation is required for discharging treated wastewater intended for reuse. The quality requirements are defined by the potential use of the wastewater that can be: (i) agriculture; (ii) non-potable urban uses and (iii) industrial uses.

In the case of agriculture or non-potable uses, the reclaimed water must meet the threshold values specified in the *Table 32*

[105] http://gazzette.comune.jesi.an.it/2003/169/2.htm

Table 32: Limit values of waste water outlet of the recovery facility) (source: Decree of Environmental Ministry 185/2003)

	Parametro	Unità di misura	Valore limite
Parametri chimico fisici	pH		6-9,5
	SAR		10
	Materiali grossolani		Assenti
	Solidi sospesi totali	mg/L	10
	BOD_5	mg O_2/L	20
	COD	mg O_2/L	100
	Fosforo totale	mg P/L	2
	Azoto totale	mg N/L	15
	Azoto ammoniacale	mg NH_4 /L	2
	Conducibilita' elettrica	µS/cm	3000
	Alluminio	mg/L	1
	Arsenico	mg/L	0,02
	Bario	mg/L	10
	Berillio	mg/L	0,1
	Boro	mg/L	1,0
	Cadmio	mg/L	0,005
	Cobalto	mg/L	0,05
	Cromo totale	mg/L	0,1
	Cromo VI	mg/L	0,005
	Ferro	mg/L	2
	Manganese	mg/L	0,2
	Mercurio	mg/L	0,001
	Nichel	mg/L	0,2
	Piombo	mg/L	0,1
	Rame	mg/L	1
	Selenio	mg/L	0,01
	Stagno	mg/L	3
	Tallio	mg/L	0, 001
	Vanadio	mg/L	0,1
	Zinco	mg/L	0, 5
	Cianuri totali (come CN)	mg/L	0,05
	Solfuri	mgH_2S/L	0,5
	Solfiti	mgSO_3/L	0,5
	Solfati	mgSO_4/L	500
	Cloro attivo	mg/l	0,2
	Cloruri	mg Cl/L	250
	Fluoruri	mg F/L	1,5
	Grassi e oli animali/vegetali	mg/L	10
	Oli minerali Nota 1	mg/L	0,05
	Fenoli totali	mg/L	0,1

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	Pentaclorofenolo	mg/L	0,003
	Aldeidi totali	mg/L	0,5
	Tetracloroetilene, tricloroetilene (somma delle concentrazioni dei parametri specifici)	mg/L	0,01
	Solventi clorurati totali	mg/L	0,04
	Trialometani (somma delle concentrazioni)	mg/L	0,03
	Solventi organici aromatici totali	mg/L	0,01
	Benzene	mg/L	0,001
	Benzo(a)pirene	mg/L	0,00001
	Solventi organici azotati totali	mg/L	0,01
	Tensioattivi totali	mg/L	0,5
	Pesticidi clorurati (ciascuno) Nota 2	mg/L	0,0001
	Pesticidi fosforati (ciascuno)	mg/L	0,0001
	Altri pesticidi totali	mg/L	0,05
Parametri microbiologici	Escherichia coli Nota 3	UFC/100mL	10 (80% dei campioni) 100 valore puntuale max
	Salmonella		Assente

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On the other hand, if the water is for industrial uses, it must comply with the restrictions provided by the discharge to surface waters (see Table 33 and Table 34).

Table 33: Emission limit values for surface water and sewer (1) (source: Decree of Environmental Ministry 185/2003)

Numero parametro	PARAMETRI	unità di misura	Scarico in acque superficiali	Scarico in pubblica fognatura (*)
1	pH		5,5-9,5	5,5-9,5
2	Temperatura	°C	(1)	(1)
3	colore		non percettibile con diluizione 1:20	non percettibile con diluizione 1:40
4	odore		non deve essere causa di molestie	non deve essere causa di molestie
5	materiali grossolani		assenti	assenti
6	Solidi sospesi totali (2)	mg/L	≤ 80	≤ 200
7	BOD_5 (come O_2) (2)	mg/L	≤ 40	≤ 250
8	COD (come O_2) (2)	mg/L	≤ 160	≤ 500
9	Alluminio	mg/L	≤ 1	≤ 2,0
10	Arsenico	mg/L	≤ 0,5	≤ 0,5
11	Bario	mg/L	≤ 20	–
12	Boro	mg/L	≤ 2	≤ 4
13	Cadmio	mg/L	≤ 0,02	≤ 0,02
14	Cromo totale	mg/L	≤ 2	≤ 4
15	Cromo VI	mg/L	≤ 0,2	≤ 0,20
16	Ferro	mg/L	≤ 2	≤ 4
17	Manganese	mg/L	≤ 2	≤ 4
18	Mercurio	mg/L	≤ 0,005	≤ 0,005
19	Nichel	mg/L	≤ 2	≤ 4
20	Piombo	mg/L	≤ 0,2	≤ 0,3
21	Rame	mg/L	≤ 0,1	≤ 0,4
22	Selenio	mg/L	≤ 0,03	≤ 0,03
23	Stagno	mg/L	≤ 10	
24	Zinco	mg/L	≤ 0,5	≤ 1,0
25	Cianuri totali (come CN)	mg/L	≤ 0,5	≤ 1,0
26	Cloro attivo libero	mg/L	≤ 0,2	≤ 0,3
27	Solfuri (come H_2S)	mg/L	≤ 1	≤ 2
28	Solfiti (come SO_3)	mg/L	≤ 1	≤ 2
29	Solfati (come SO_4) (3)	mg/L	≤ 1000	≤ 1000
30	Cloruri (3)	mg/L	≤ 1200	≤ 1200
31	Fluoruri	mg/L	≤ 6	≤ 12
32	Fosforo totale (come P) (2)	mg/L	≤ 10	≤ 10
33	Azoto ammoniacale (come NH_4) (2)	mg/L	≤ 15	≤ 30
34	Azoto nitroso (come N) (2)	mg/L	≤ 0,6	≤ 0,6
35	Azoto nitrico (come N) (2)	mg/L	≤ 20	≤ 30

Table 34: Emission limit values for surface water and sewer (2) (source: Decree of Environmental Ministry 185/2003)

Numero parametro	SOSTANZE	unità di misura	Scarico in acque superficiali	Scarico in pubblica fognatura (*)
36	Grassi e oli animali/vegetali	mg/L	≤ 20	≤ 40
37	Idrocarburi totali	mg/L	≤ 5	≤ 10
38	Fenoli	mg/L	≤ 0,5	≤ 1
39	Aldeidi	mg/L	≤ 1	≤ 2
40	Solventi organici aromatici	mg/L	≤ 0,2	≤ 0,4
41	Solventi organici azotati	mg/L	≤ 0,1	≤ 0,2
42	Tensioattivi totali	mg/L	≤ 2	≤ 4
43	Pesticidi fosforati	mg/L	≤ 0,10	≤ 0,10
44	Pesticidi totali (esclusi i fosforati) (5) tra cui:	mg/L	≤ 0,05	≤ 0,05
45	– aldrin	mg/L	≤ 0,01	≤ 0,01
46	– dieldrin	mg/L	≤ 0,01	≤ 0,01
47	– endrin	mg/L	≤ 0,002	≤ 0,002
48	– isodrin	mg/L	≤ 0,002	≤ 0,002
49	Solventi clorurati	mg/L	≤ 1	≤ 2
50	*Escherichia coli* (4)	UFC/100 mL	nota	
51	Saggio di tossicità acuta (5)		il campione non è accettabile quando dopo 24 ore il numero degli organismi immobili è uguale o maggiore del 50% del totale	il campione non è accettabile quando dopo 24 ore il numero degli organismi immobili è uguale o maggiore dell 80% del totale

These quality requirements are focused on 55 bacteriological and physico-chemical parameters. For parameters such pH, ammonia nitrogen, specific electrical conductivity,

aluminium, iron, manganese, chloride and sulphate concentrations, regional authorities set limit values other than those mentioned in the Decree (after validation from the Ministry of Environment and the authorities in charge of the Protection of Natural Resources). For example, in Sicily, microbiological standards are similar to those of the WHO guidelines.

In contrast to French legislation, the Italian legislation forces those distribution network owners to monitor the reclaimed water analysing chemical and microbiological parameters, environmental and agronomical impacts, and impacts on soil. Furthermore, the monitoring results shall be sent to the regional authorities every year. Also, a Control & Monitoring Plan to be implemented by the WWTP operator is set out in the discharge permit; this plan shall be proposed by the WWTP manager and agreed by the competent authority.

5.5.2 Health Legislation and Considerations

The Decree 31/2001[106] of February is transposed from the 98/83/CE Directive and establishes the quality water intended for human consumption in Italy.

Additionally, the Italian legislation remark two important issues related with the public health which are: (i) the treated wastewater distribution network shall be separated from the drinking water supply network and constructed so as to avoid across contamination and (ii) reclaimed water delivery points shall be marked and clearly distinguishable from those of water intended for human consumption.

5.5.3 Economic Legislation and Considerations

Italian legislation has several economic benefits for the industrial use of the reclaimed water. One of them is defined by article 155(6) of the Decree 152/2006, it orders that tariffs for industrial users be discounted to promote wastewater reuse for productive activities as a function of the volume of the reused water and of the quantity of fresh water used. Other profit is defined in the Ministerial Decree 185/2003 where require the free supply of treated wastewater from WWTP to the distribution network, as well as adequate cost recovery for the distribution of treated wastewater.

On the other hand, the National Irrigation Plan adopted by the Italian Ministry of Agriculture promotes treated wastewater reuse for irrigation and finances irrigation infrastructure including for reused water.

A methodology for assessing the technical and economic feasibility of treated wastewater reuse was developed by ISPRA (Institute for Environmental Protection and Research) in 2012[107].

[106] *http://www.geologi.it/leggi/dlgs31-2001.htm*

[107] *http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/modello-di-indagine-per-la-valutazione-della-fattibilita-del-riuso-delle-acque-reflue-depurate*

5.5.4 Conclusions

The Italian water sector is characterised by a lot of heterogeneity, often inherited from the past implementation of rules in the different local areas. In the last years, there has been important progress on water environmental legislation and regulation, mainly prompted by EU environmental directives. During 1990s new economic instruments and voluntary agreements were defined such as benefits for the industrial use of the reclaimed water discounted to promote wastewater reuse for productive activities, free supply of treated wastewater from WWTP to the distribution network, as well as adequate cost recovery for the distribution of treated wastewater. Therefore, INNOQUA can take advantage of the water reuse benefits to enter in the Italian market. On the other hand, INNOQUA should to take into account that the Italian legislation for wastewater reuse and discharge is very restrictive with more or less 50 quality parameters to be monitored and whose results shall be sent to the regional authorities every year.

5.6 Spain

5.6.1 Environmental Legislation and Considerations

Regarding the discharge of treated wastewater into continental water bodies, the reference documents in Spain are the Law of waters, approved by “Royal decree 1/2001”, and the Code of the public hydraulic domain, approved by “Royal decree 849/1986”. The hydraulic administration is the one that owns the competences to give the permissions for the discharge of treated wastewater into the continental water bodies. This regulation is complemented by the legislation derived from the transposition of the European Community regulations in the subject of integrated prevention and control of pollution, which is constituted by the Law 16/2002 for the integrated prevention and control of pollution (the national basic rule in Spain) and the Law 20/2009 for the prevention and environmental control of activities (in Catalonia).

The urban wastewater collection, treatment and discharge systems are defined by the Directive 91/271/EEC, which was modified by the Directive 98/15/EEC. The transposition of the Directive to the Spanish regulation was made by the “Royal decree 11/1995”, the “Royal decree 509/1996” (which develops the former decree) and the “Royal decree 2116/1998”, which modifies the former one. The secondary treatment to be performed (minimal requirements) according to the size of the agglomerations discharging to the wastewater collection systems and the requirements to be committed in order to obey the discharge limits imposed by the Directive 91/271 EEC (in its Annex I) and the derived regulations in Spain are summarised in the following tables, Table 35 and Table 36.

Table 35: Secondary Treatment Requirements

TABLA 2. REQUISITOS PARA LOS VERTIDOS PROCEDENTES DE INSTALACIONES DE DEPURACIÓN DE AGUAS RESIDUALES URBANAS MEDIANTE TRATAMIENTO SECUNDARIO (a)		
Parámetros	**Concentración**	**Porcentaje mínimo de reducción** (b)
DBO_5 (c) (a 20º C sin nitrificación)	25 mg/L O_2	70-90 %
DQO	125 mg/L O_2	75 %
Total sólidos en suspensión	35 mg/L (d)	90 % (d)

(a) O proceso equivalente. Se aplicará el valor de concentración o el porcentaje de reducción.
(b) Reducción relacionada con la carga del caudal de entrada.
(c) Este parámetro puede sustituirse por otro: carbono orgánico total (COT) o demanda total de oxígeno (DTO), si puede establecerse una correlación entre la DBO_5 y el parámetro sustituto.
(d) Este requisito es optativo. Los análisis de vertidos procedentes de sistemas de depuración por lagunaje se llevarán a cabo sobre muestras filtradas; no obstante, la concentración de sólidos en suspensión en las muestras de agua sin filtrar no deberá superar los 150 mg/L.

Table 36: Stringent Treatment Requirements

TABLA 5. REQUISITOS PARA LOS VERTIDOS PROCEDENTES DE INSTALACIONES DE DEPURACIÓN DE AGUAS RESIDUALES URBANAS MEDIANTE TRATAMIENTO MÁS RIGUROSO (a)			
Parámetros	**Concentración**		**Porcentaje mínimo de reducción** (b)
	10.000 a 100.000 h-e	**> 100.000 h-e**	
Fósforo total	2 mg/L P	1 mg/L P	80 %
Nitrógeno total (c) (mg/L N)	15 mg/L N (d)	10 mg/L N	70-80 %

(a) Según la situación local se podrá aplicar uno o los dos parámetros. Se aplicará el valor de concentración o el porcentaje de reducción
(b) Reducción relacionada con la carga del caudal de entrada
(c) Nitrógeno total equivalente a la suma del nitrógeno Kjeldahl total (N orgánico y amoniacal), nitrógeno en forma de nitrato (NO_3) y nitrógeno en forma de nitrito (NO_2)
(d) Estos valores de concentración constituyen medias anuales según el punto 3º del apartado A) 2 del Anexo III del RD. 509/96. No obstante, los requisitos relativos al nitrógeno pueden comprobarse mediante medias diarias cuando se demuestre, que de conformidad con el apartado A)1 del Anexo III se obtiene el mismo nivel de protección. En ese caso la media diaria no deberá superar los 20 mg/L de Nitrógeno total para todas las muestras, cuando la temperatura del efluente del reactor biológico sea superior o igual a 12 º C. En sustitución del requisito relativo a la temperatura, se podrá aplicar una limitación del tiempo de funcionamiento que tenga en cuenta las condiciones climáticas regionales

This discharge limits could not be applied to individual facilities when the total load reduction for all the facilities discharging to the vulnerable zone accounts for up to 75% of the total P and total N, respectively. However, the discharge permissions for WWTP could impose more restrictive discharge limits in order to guarantee that the receiving water bodies can cope with the objectives fixed by the current legislation.

For small agglomerations (i.e. below 2000 PE) the regulations only specify that “the proper treatment must be applied”, without specification about the treatment and discharge limits

requirements. The only requirement is to keep the quality of the receiving water body in agreement with the legal requirements after the discharge of the treated wastewater.

The number of samples to be regularly collected in order to perform the yearly monitoring and control of the WWTP facilities is given by the following table, Table 37, according to the size of the WWTP.

Table 37: Sampling Requirements in Accordance with WWTP Size

TABLA 7. FRECUENCIA DE MUESTREO EN VERTIDOS DE INTALACIONES DE DEPURACIÓN DE AGUAS RESIDUALES URBANAS	
Tamaño de la instalación	**Número mínimo anual de muestras**
2.000 ≤ h-e < 10.000	12 (a)
10.000 ≤ h-e < 50.000	12
h-e ≥ 50.000	24

(a) Durante el primer año. En años sucesivos 4 muestras/año, siempre que pueda demostrarse que el vertido durante el primer año es conforme a lo establecido en la normativa; si una de las cuatro muestras resultara no conforme, se tomarán 12 muestras el siguiente año.

The Spanish reference document to treat wastewater is the “Royal Decree 1620/2007”108 of December that provides the legal regime applicable to the reuse of treated water. From its entry into force, this regulation has boosted water reuse in Spain. This regulatory instrument allows to include water reuse within hydrological planning, thus ensuring an adequate protection of the human health and of the environment. It divides the potential uses on 24 categories classified on five sectors. These sectors and categories are: (i) urban (residential areas; services) (see Table 38); (ii) agriculture (food crops intended for human consumption, consumed raw; food crops intended for human consumption, industrially processed; aquaculture; grassland; localised irrigation for woody cultures for which water can be in contact with fruits intended for human consumption; flowering plant irrigation without direct contact with water; industrial crops not intended for human consumption) (see Table 39) (iii) industry (water for industrial processes or cleaning (except for food industry); water for industrial process and cleaning for food industry; cooling towers and evaporative condensers) (Table 40);(iv) recreational area (golf courses; ponds)(Table 42); and (v) environmental (aquifer recharge by infiltration; aquifer recharge by injection; forests accessible to the public; wetlands) (Table 43).

[108] http://www.boe.es/diario_boe/txt.php?id=BOE-A-2007-21092

Table 38: Quality criteria for water reuse in urban sector (source: Royal Decree 1620/2007)

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES[1]	ESCHERICHIA *COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
1.- USOS URBANOS					
CALIDAD 1.1: RESIDENCIAL[2] a) Riego de jardines privados.[3] b) Descarga de aparatos sanitarios.[3]	1 huevo/10 L	0 (UFC[4]/100 mL)	10 mg/L	2 UNT[5]	OTROS CONTAMINANTES[6] contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas[7] deberá asegurarse el respeto de las NCAs.[8] *Legionella spp.* 100 UFC/L (si existe riesgo de aerosolización)
CALIDAD 1.2: SERVICIOS a) Riego de zonas verdes urbanas (parques, campos deportivos y similares).[9] b) Baldeo de calles.[9] c) Sistemas contra incendios.[9] d) Lavado industrial de vehículos.[9]	1 huevo/10 L	200 UFC/100 mL	20 mg/L	10 UNT	

[1] Considerar en todos los grupos de calidad al menos los géneros: *Ancylostoma, Tnchuns y Ascaris.*

[2] Deben someterse a controles que aseguren el correcto mantenimiento de las instalaciones.

[3] Su autorización estará condicionada a la obligatoriedad de la presencia doble circuito señalizado en todos sus tramos hasta el punto de uso

[4] Unidades Formadoras de Colonias.

[5] Unidades Nefelométricas de Turbiedad.

[6] ver el Anexo II del RD 849/1986, de 11 de abril.

[7] ver Anexo IV del RD 907/2007, de 6 de julio.

[8] Norma de calidad ambiental ver el artículo 245.5.a del RD 849/1986, de 11 de abril, modificado por el RD 606/2003 de 23 de mayo.

[9] Cuando exista un uso con posibilidad de aerosolización del agua, es imprescindible seguir las condiciones de uso que señale, para cada caso, la autoridad sanitaria, sin las cuales, esos usos no serán autorizados

Table 39: Quality criteria for water reuse in agriculture sector (source: Royal Decree 1620/2007)

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCMERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
2.- USOS AGRÍCOLAS[1]					
CALIDAD 2.12 a) Riego de cultivos con sistema de aplicación del agua que permita el contacto directo del agua regenerada con las partes comestibles para alimentación humana en fresco.	1 huevo/10 L	100 UFC/100 mL Teniendo en cuenta un plan de muestreo a 3 clases[3] con los siguientes valores: n =10 m=100 UFC/100 mL M=1.000 UFC/100 mL c=3	20 mg/L	10 UNT	OTROS CONTAMINANTES Contenidos en la autorización de vertido de aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Legionella spp.* 1.000 UFC/L (si existe riesgo de aerosolización) Es obligatorio llevar a cabo la detección de patógenos Presencia/Ausencia (Salmonella, etc.) cuando se repita habitualmente que c=3 para M=1.000

[1] Características del agua regenerada que requieren información adicional: Conductividad 3,0 dS/m ; Relación de Adsorción de Sodio (RAS): 6 meq/L; Boro: 0,5 mg/L; Arsénico: 0,1 mg/L; Berilio: 0,1 mg/L; Cadmio: 0,01 mg/L; Cobalto: 0,05 mg/L; Cromo: 0,1 mg/L; Cobre: 0,2 mg/L; Manganeso: 0,2 mg/L; Molibdeno: 0,01 mg/L; Níquel: 0,2 mg/L; Selenio : 0,02 mg/L; Vanadio: 0,1 mg/L.
Para el cálculo de RAS se utilizará la fórmula:

$$RAS(meq/L) = \frac{[Na]}{\sqrt{\frac{[Ca]+[Mg]}{2}}}$$

[2] Cuando exista un uso con posibilidad de aerosolización del agua, es imprescindible seguir las condiciones de uso que señale, para cada caso, la autoridad sanitaria, sin las cuales, esos usos no serán autorizados

[3] Siendo n: nº de unidades de la muestra; m: valor límite admisible para el recuento de bacterias; M: valor máximo permitido para el recuento de bacterias; c: número máximo de unidades de muestra cuyo número de bacterias se sitúa entre m y M.

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	ESCHERICHIA *COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
CALIDAD 2.2 a) Riego de productos para consumo humano con sistema de aplicación de agua que no evita el contacto directo del agua regenerada con las partes comestibles, pero el consumo no es en fresco sino con un tratamiento industrial posterior. b) Riego de pastos para consumo de animales productores de leche o carne. c) Acuicultura.	1 huevo/10 L	1.000 UFC/100 mL Teniendo en cuenta un plan de muestreo a 3 clases[1] con los siguientes valores: n =10 m=1.000 UFC/100 mL M=10.000 UFC/100 mL c=3	35 mg/L	No se fija límite	OTROS CONTAMINANTES Contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Taenia saginata y Taenia solium:* 1 huevo/L (si se riegan pastos para consumo de animales productores de carne) Es obligatorio llevar a cabo detección de patógenos Presencia/Ausencia (*Salmonella*, etc.) cuando se repita habitualmente que c=3 para M=10.000
CALIDAD 2.3 a) Riego localizado de cultivos leñosos que impida el contacto del agua regenerada con los frutos consumidos en la alimentación humana. b) Riego de cultivos de flores ornamentales, viveros, invernaderos sin contacto directo del agua regenerada con las producciones. c) Riego de cultivos industriales no alimentarios, viveros, forrajes ensilados, cereales y semillas oleaginosas.	1 huevo/10 L	10.000 UFC/100 mL	35 mg/L	No se fija límite	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Legionella spp.* 100 UFC/L

[1] Siendo n: nº de unidades de la muestra; m: valor límite admisible para el recuento de bacterias; M: valor máximo permitido para el recuento de bacterias; c: número máximo de unidades de muestra cuyo número de bacterias se sitúa entre m y M.

Table 40: Quality criteria for water reuse in industry sector (source: Royal Decree 1620/2007)

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCHERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
3.- USOS INDUSTRIALES					
CALIDAD 3.1[1] a) Aguas de proceso y limpieza excepto en la industria alimentaria. b) Otros usos industriales.	No se fija límite	10.000 UFC/100 mL	35 mg/L	15 UNT	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Legionella spp.*: 100 UFC/L
c) Aguas de proceso y limpieza para uso en la industria alimentaria	1 huevo/10 L	1.000 UFC/100 mL Teniendo en cuenta un plan de muestreo a 3 clases[2] con los siguientes valores: n=10 m =1.000 UFC/100 mL M=10.000 UFC/100 mL c=3	35 mg/L	No se fija límite	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Legionella spp.*:100 UFC/L Es obligatorio llevar a cabo detección de patógenos Presencia/Ausencia (*Salmonella*, etc.) cuando se repita habitualmente que c=3 para M=10.000
CALIDAD 3.2 a) Torres de refrigeración y condensadores evaporativos.	1 **huevo/10 L**	Ausencia UFC/100 mL	5 mg/L	1 UNT	*Legionella spp.*: Ausencia UFC/L Para su autorización se requerirá: – La aprobación, por la autoridad sanitaria, del Programa específico de control de las instalaciones contemplado en el Real Decreto 865/2003, de 4 de julio, por el que se establecen los criterios higiénico-sanitarios para la prevención y control de la legionelosis. – Uso exclusivamente industrial y en localizaciones que no estén ubicadas en zonas urbanas ni cerca de lugares con actividad pública o comercial.

[1] Cuando exista un uso con posibilidad de aerosolización del agua, es imprescindible seguir las condiciones de uso que señale, para cada caso, la autoridad sanitaria, sin las cuales, esos usos no serán autorizados

[2] Siendo n: n° de unidades de la muestra; m: valor límite admisible para el recuento de bacterias; M: valor máximo permitido para el recuento de bacterias; c: número máximo de unidades de muestra cuyo número de bacterias se sitúa entre m y M.

Table 41: Quality criteria for water reuse in recreational sector (source: Royal Decree 1620/2007)

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCHERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
4.- USOS RECREATIVOS					
CALIDAD 4.1[1] a) Riego de campos de golf.	1 huevo/10 L	200 UFC/100 mL	20 mg/L	10 UNT	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. Si el riego se aplica directamente a la zona del suelo (goteo, microaspersión) se fijan los criterios del grupo de Calidad 2.3 *Legionella spp.* 100 UFC/L (si existe riesgo de aerosolización)
CALIDAD 4.2 a) Estanques, masas de agua y caudales circulantes ornamentales, en los que está impedido el acceso del público al agua.	No se fija límite	10.000 UFC/100 mL	35 mg/L	No se fija límite	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. P_T : 2 mg P/L (en agua estancada)

[1] Cuando exista un uso con posibilidad de aerosolizacion del agua, es imprescindible seguir las condiciones de uso que señale, para cada caso, la autoridad sanitaria, sin las cuales, esos usos no serán autorizados.

Table 42: Quality criteria for water reuse in environment sector (source: Royal Decree 1620/2007)

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCHERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
5.- USOS AMBIENTALES					
CALIDAD 5.1 a) Recarga de acuíferos por percolacion localizada a través del terreno.	No se fija límite	1.000 UFC/100 mL	35 mg/L	No se fija límite	N_T[1] 10 mg N/L NO_3: 25 mg NO_3/L Art. 257 a 259 del RD 849/1986
CALIDAD 5.2 a) Recarga de acuíferos por inyección directa	1 huevo/10 L	0 UFC/100 mL	10 mg/L	2 UNT	
CALIDAD 5.3 a) Riego de bosques, zonas verdes y de otro tipo no accesibles al público. b) Silvicultura.	No se fija límite	No se fija límite	35 mg/L	No se fija límite	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs
CALIDAD 5.4 a) Otros usos ambientales (mantenimiento de humedales, caudales mínimos y similares).	La calidad mínima requerida se estudiará caso por caso				

[1] Nitrógeno total, suma del nitrógeno inorgánico y orgánico presente en la muestra.

Also, a minimum frequency of sampling and analysis of each parameter is defined by the reference document. These measurements shall take place at the outlet of the regeneration plant, and at all points of delivery to the user. Below, the Table 43 presents the monitoring requirements.

Table 43: Minimum frequency of sampling and analysis of each parameter (source: Royal Decree 1620/2007)

Uso	Calidad	Nematodos Intestinales	*Escherichia Coli*	SS	Turbidez	NT y PT	Otros contaminantes	Otros criterios
1.- USO URBANO	1.1 y 1.2	Quincenal	2 veces semana	Semanal	2 veces semana	–	El Organismo de cuenca valorará la frecuencia de análisis sobre la base de la autorización de vertido y del tratamiento de regeneración.	Mensual
2.- USO AGRARIO	2.1	Quincenal	Semanal	Semanal	Semanal	–		Mensual
	2.2	Quincenal	Semanal	Semanal	–	–		Quincenal
	2.3	Quincenal	Semanal	Semanal	–	–		–
3.- USO INDUSTRIAL	3.1	–	Semanal	Semanal	Semanal	–		Mensual
	3.2	Semanal	3 veces semana	Diaria	Diaria	–		*Legionella spp.* 3 veces semana
4.- USO RECREATIVO	4.1	Quincenal	2 veces semana	Semanal	2 veces semana	–		–
	4.2	–	Semanal	Semanal	–	Mensual		–
5.- USO AMBIENTAL	5.1	–	2 veces semana	Semanal	–	Semanal		–
	5.2	Semanal	3 veces semana	Diaria	Diaria	Semanal		Semanal
	5.3	–	–	Semanal	–	–		–
	5.4							Frecuencia igual al uso más similar

On the other hand, the water use in Spain is forbidden for several categories such as water intended for human consumption (except in catastrophe situation), use in hospitals, bathing water, fountain or ornamental products in public spaces, and all other uses presenting health risks.

In addition to the Royal Decree 1620/2007, the Spanish legislation has more laws not so relevant for INNOQUA project but equally remarkable.

Regulation providing the water status monitoring and assessment criteria and the environmental quality standards, approved by Royal Decree 817/2015, of 11 September. The purpose of this Royal Decree is: (i) laying down basic and homogeneous criteria for the design and implementation of the surface water status monitoring programmes, as well as for the additional control of protected areas; (ii) defining the criteria, reference conditions and change of category to classify the ecological status of water bodies; (iii) providing the environmental quality standards for priority and preferential substances to classify water status, as well as defining the procedure to assess these rules for point-source pollutants; and finally, (iv) providing for the information exchange obligations whilst defining the information system on the status of waters in order to comply with the applicable legislation on the rights of access to information and public information.

Act 11/2005, of 22nd June, amending Act 10/2001, of 5th July, approving the National Hydrological Plan, provided a definition of ecological flows and of river nature reserves along with a section on hydraulic works of general interest.

In order to promote reuse activities, the use of reclaimed water is an obligation in some regions and for specific uses. For instance, in Madrid it is compulsory to use reclaimed water to irrigate golf courses. The same requirement exists in Andalucía. In other regions, reuse of treated water is not compulsory but it is highly recommended, e.g. for industrial uses in the Region of Madrid.

5.6.2 Health Legislation and Considerations

The Royal Decree 140/2003[109] of February stablishes the health criteria for the quality of water intended for human consumption. It also establishes water control, guaranteeing its safety, quality and cleanliness, in order to protect the population's health from the adverse effects of contaminated water.

Spain developed a National Plan for Water Reuse (NPWR)[110] in 2012 whose aim at developing the legal framework for water reuse through initiatives or plans by public administrations, recognising that water reuse projects are often driven and encouraged by local authorities. It includes the following key action areas: (i) development of the legal framework for water reuse through initiatives or plans by public administrations; (ii) identification and construction of the infrastructures necessary to achieve the objectives set in the Plan; (iii) drafting a Guide of Good Practices in Water Reuse; (iv) promotion of research, development, and innovation actions; and (v) dissemination of information, communication and public participation.
Also the Catalan Water Agency (ACA) set up a Water Reuse Programme[111] to reach the goal of 200 million m3 of reused water by 2016, which would mean that 31% of treated water would be reused. This document sets out: (i) the reuse infrastructure to be promoted by the Government of Catalonia; (ii) the definition of uses that are considered most appropriate for each treatment system; (iii) the proposal for a new management framework for this activity to allow it to be better developed, including the definition of the financing criteria for the different actions and mechanisms through which to recovery public expenditure on investment and exploitation; and (iv) the establishment of quality criteria for reclaimed water in addition to automatic control measures.

5.6.3 Economic Legislation and Considerations

Spain approved "urgent environmental measures" law in May 2012 including a clause specifically creating exceptions to the application of the full cost recovery for water-related services; such a clause may contravene the promotion of water reuse. On the other hand, some entities such as Costa Brava Consortium and Catalan Water Agency have taken action providing economic benefits. For instance, the Costa Brava Consortium has created a regulation allowing exemption of the user tax for reclaimed water. Instead, the Catalan Water

[109] http://www.msssi.gob.es/profesionales/saludPublica/docs/rd_140_2003.pdf
[110] http://www.magrama.gob.es/es/calidad-y-evaluacion-ambiental/participacion-publica/version_preliminar_pnra231210_tcm7-153069.pdf
[111] http://aca-web.gencat.cat/aca/documents/ca/planificacio/reutilitzacio/PRAC_V_3_1.pdf

Agency has approved a new tax that applies to the use of drinking water used by the municipalities encouraging for the municipalities to develop usable local resources such as reclaimed water.

5.6.4 Conclusions

Spain is one of the worldwide pioneering countries in establishing standards of quality for water reuse (RD1620/2007 of December, 7th). These standards clarify several concepts related to the reuse of water, establishes the permitted (urban, agricultural, recreational, industrial and environmental) and prohibited (human consumption) uses, standardises the administrative procedures for obtaining the right to use and establishes the parameters of quality and maximum values allowed for each use, also determining the regime of control and responsibilities in relation to the maintenance of the quality.

As a result of the wide experience gained by the different actors involved in the reuse of water in Spain, the technologies for the regeneration of purified water and the practices for maintaining quality from transport to point of use have been developed and improved, with a considerable increase in performance and a reduction of costs that allows this resource to compete on an equal basis with other alternatives. Spain (except the Cantabrian area) and most of Mediterranean climate areas in Europe present a Water Exploitation Index (WEI, use of water compared to general availability) above 40%, which indicates extreme water stress (EEA, 2012). On top of that, water scarcity and droughts are increasingly frequent and reuse of water is a very important issue for Spain as well as for other countries having recurrent droughts and structural lack of water in certain areas. The development of new technologies such as those involved in the INNOQUA project will be a good example of these achievements of the Spanish water sector that can be improved and become more competitive due to the collaboration with the rest of European technologies developers involved in the project.

6 Latin America

Wastewater treatment in Latin America is an important issue. Although efforts were realised in large cities to install sewage collection networks, the degree of final treatment remains very low.

Table 44: Waste water treatment coverage per country in Latin America[112]

WASTEWATER TREATMENT PER COUNTRY					
LESS THAN 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	MORE THAN 50%
COSTA RICA	ARGENTINA	BOLIVIA	BRASIL	NICARAGUA	CHILE
	PARAGUAY	COLOMBIA	MEXICO		URUGUAY
ECUADOR		PANAMA	DOMINICAN REPUBLIC		
EL SALVADOR		PERU			
GUATEMALA		VENEZUELA			
HONDURAS					

To improve this situation, the institutional structure of the sector has changed in many countries. These reforms have boosted the institutional separation of the leadership functions and the definition of sectoral policies with respect to economic regulation and provision of services. However, the sectoral rules of various countries needs to be updated according to new contexts, constitutional changes and emerging challenges. For example, the separation of corporate functions is still incipient in some of them. Another trend is the decentralisation of the provision of services, almost always to the municipal level. Third, in many cases, they have adopted policies to ensure the political administration of services with a technical and commercial criteria. However, many public providers still have a high dependence on corporate governance with the central government or subnational level, which reduces their autonomy.

In connection with the plans and goals of the countries of the region, several have high nominal coverage or even aspire to achieve the universality of services in the coming years. However, it is likely that some of them will not reach the Millennium Development Goals (MDGs) with regard access to drinking water. As regards to sanitation, the situation is more critical. Therefore, the region needs to step up the pace of implementation and the quality of sectorial investments, which requires advocacy work and generate greater capacity and efficiency in execution.

This situation is complicated by the absence or poor quality of information on the actual status of the systems, the ability to pay of users and, therefore, actual investment needs. The sustainability of investments is another equally important aspect, which reflect countries asymmetrically in their respective plans and institutions.

[112] *Water and wastewater International, vo.31, issue 15, 2016,Sofia Berger*

6.1.1 Environmental Legislation and Considerations

Several countries in the region have specific sectoral laws on drinking water and sanitation, at national level national (Bolivia, Chile, Peru, Paraguay, Costa Rica, Honduras, etc.) or at sub-national level (like Argentina), while others integrate guidelines contained in sectoral laws for health or environment, or laws are derived from water laws (Nicaragua, Ecuador, Uruguay and several English-speaking countries of the Caribbean). Countries with greater coverage of services typically do not have specific sectoral national plans, which may be due precisely to the extensive coverage (Barbados, Chile, Costa Rica, Uruguay, Colombia and Trinidad and Tobago) or its federal nature (Argentina), however they are various sectoral guidelines in broader plans, such as sustainable development or national development.

Meanwhile, it has been common for countries with higher backlogs to develop sectoral national plans. However, evidence indicates that the vast majority have not been met, largely because they include very ambitious goals, looking to quickly reduce the gaps, and so become unviable. This phenomenon can be seen in various schemes, where it is postulated to achieve universality of services or to achieve high coverage in relatively short periods, which means doubling or tripling its historical investments. It is observed in general a concentration of capital funding in national or federal programs which are lacking of criteria associated with results and are often reactive and regressive.

6.1.2 Health Legislation and considerations

Spears[113] collected information from 140 demographic and health reports throughout the world and concluded that there is a high correlation between open defecation and malnutrition (also known as stunting). This empirical evidence adds to other research indicating that chronic malnutrition occurs mainly during pregnancy and in the first two years of the child, being an irreversible problem where the affected will have little chance to develop fully, including risk of death, with deep family consequences that perpetuate the cycle of poverty, inequality and social damage. To this known diseases generated by contact with bacteria and pathogens by the lack of potable water and sanitation in the home, such as Escherichia coli, which attacks the body and generates loss of salts and other nutrients are added, affecting especially the children. Diarrhea associated with dehydration, is one of the leading causes of death in developing countries. Therefore, the provision of potable water and sanitation is essential because it affects the health and contributes to reducing poverty.

[113] Spears, Dean (2013), The nutritional value of toilets: How much international variation in child height can sanitation explain?, Centre for Development Economics, Delhi School of Economics, Delhi, India

6.1.3 Economic Legislation and Considerations

In Latin America[114] governments have been the traditional funding source for wastewater infrastructure. Resource constraints and the scale of the needed investments have limited what governments can do. To close that gap, funding from development banks and multilateral lending institutions like the World Bank has become increasingly important across the region, especially as global commodities - a major income generator for some Latin American countries - have experienced steep price declines. Even provider fees can be funding sources, but on a much smaller scale, for wastewater projects in the region. Each country will approach the funding question based on its own context.

In Panama, funding is provided by both the government and development banks, and in Cuba, it's expected that the government and also multilateral lending institutions and foreign development agencies will be the funding source for water and wastewater projects.

Interestingly, Peru has seen good results with public-private partnership funding models. There, potable water and wastewater infrastructure were both enhanced to benefit local, often underserved communities, where sanitary facilities had been lacking. Elsewhere in Latin America, such as Panama, policymakers and funders are making substantive investments in wastewater treatment and sanitation services, with a particular focus on traditionally underserved communities

Goal- and data-based international development initiatives, such as the UN's sustainable development goals (SDGs), are also sharpening the focus on wastewater treatment efforts in the region. Besides the World Bank, the Inter-American Development Bank (IADB) and the Development Bank of Latin America (CAF) have become major investors in Latin America's wastewater infrastructure, in alignment with their mission and the SDGs. For instance, IADB and CAF have mapped out their water and wastewater system investments between 2010 and 2030.

These wastewater treatment investments will involve outlays, but an ecosystem of new funders and funding approaches are now in place. Perhaps most important, given the recognition of the growing need for these investments, there's an opportunity for greater public involvement and buy-in that gives these investments wider legitimacy and demonstrates how they're geared to solve, affordably and effectively, Latin America's wastewater needs.

[114] Water and wastewater International, vo.31, issue 15, 2016, Sofia Berger

6.1.4 Conclusions

The degree of wastewater sanitation and treatment varies throughout Latin America, some countries have well developed sanitation and treatment and are currently investing in local treatment, whilst others are not so well progressed but have developed a national framework for implementation.

Historic funding from local government has been reliant upon market commodity values, which are now much reduced, meaning that funds must be sourced elsewhere either through public private partnerships or local development banks.

The analysis of legal frameworks leads to the conclusion that there is no paradigmatic models in Latin America, as each responds to different development processes, to alternative world views that coexist even within the same continent. For example, several countries have a regulatory framework that was developed in order to promote private sector participation, although for almost all of them the presence of private providers is minimal or non-existent. Accordingly, to the extent that for several countries their own constitution defines the nationalisation of public drinking water and sanitation, it is necessary that sectoral laws conform in accordance with that mandate.

6.2 Peru

6.2.1 Environmental Legislation and Considerations

Environment General Act – 'Ley General del Ambiente (Ley N° 28611)'
This Act is the single most important legal document dedicated to environmental protection and management in the country. For the purposes of the project, some of the most relevant content is outlined below.

Art. 31° refers to Environmental Quality Standards (ECA) which represent the measure that sets the level of concentration or degree of elements, substances or physical, chemical and biological parameters in the air, water or soil, in its capacity of receiving body, which does not pose significant risk to people's health or to the environment. Depending on the parameter, the concentration or degree may be expressed as maximum, minimum or ranges.

Art. 121° refers to wastewater shedding. In this regard, the State, based on the capacity of receiving bodies, issues a prior authorisation for the discharge of domestic and industrial wastewater or from any other activity performed by natural or legal persons, provided that such discharge will not cause deterioration in the quality of the waters as receiving body, and will not affect reuse for other purposes, according to the provisions of the relevant ECA and legal standards.

Art. 122° refers to the treatment of liquid waste, stating that the responsibility for the treatment of domestic liquid waste and rainwater belongs to the entities responsible for sanitation services. Moreover, the Housing, Construction and Sanitation sector is responsible for monitoring and sanctioning the breach of maximum permissible limits (LMP) in domestic liquid waste, in coordination with sectoral authorities with functions related to effluents discharge into the public sewer system. In addition, companies or entities that develop productive, mining and marketing activities or others that generate wastewater or sewage, are responsible for their treatment, to reduce their pollution levels to levels compatible with the Maximum Permissible Limits (LMP), the ECA and other standards set in environmental management instruments in accordance with the provisions of current legislation. The management of wastewater or sewage from industrial sources can be performed directly by the generator, through third parties duly authorised or through the entities responsible for sanitation, within the existing legal framework on the subject.

Water Resources Act – 'Ley de Recursos Hídricos (Ley N° 29338)'

This Law regulates the use and integrated management of water resources, the performance of the state and individuals in this management, as well as the associated assets. It includes surface, underground and continental water; associated assets; and also extends to sea and atmospheric water as applicable.

Some of the most important considerations for the purposes of the project are outlined below.

Art. 76° refers to monitoring and control of water, stating that the National Authority in coordination with the Watershed Council are responsible to control, supervise and monitor compliance with the Environmental Quality Standards for Water (ECA-Water) and provisions and programs for implementation established by the environmental authority. It also establishes measures to prevent, control and remediate pollution of water and associated assets. It implements surveillance and monitoring activities, especially in the basins where there are activities that endanger the quality or quantity of the resource.

Art. 79° indicates that wastewater can only be discharged with a previous favourable technical opinion from the Environmental and Health Authority regarding its compliance with the Environmental Quality Standards for Water (ECA-Agua) and LMP. Direct or indirect discharges without this authorisation are prohibited.

Art. 80° sets that in order to get a discharge authorisation, the environmental instrument should contemplate the possibility of prior treatment as well as corroborate that the receptor conditions will allow natural processes of purification. This authorisation will be issued for a limited period of time.

Art. 82° refers to the reuse of wastewater, stating that the National Authority, through the Watershed Council authorises the reuse of treated wastewater, according to the purpose for

which it is intended, in coordination with the competent sector authority and, where appropriate, with the National Environmental Authority. In addition, the holder of a license to use water is authorised to reuse generated wastewater provided that is meant for the same purposes for which the license was granted. For different activities, authorisation is required. Another factor to take into account is that the distribution of treated wastewater should consider the water supply in the basin necessarily.

Bylaw of the Water Resources General Act - 'Reglamento de la Ley General de Recursos Hídricos (D.S. N° 001-2010-AG)'

The purpose of this bylaw is to regulate the use and management of water resources, and the associated assets; and the performance of the State and individuals in such management, all in accordance with the provisions of the Water Resources Act.

This document includes the conditions to authorise the discharge of treated wastewater (Art. 133°); the content for the environmental instrument to be applied (Art. 134°); regulations regarding the prohibition of discharges with no license (Art. 135°), the granting of discharge licenses for treated wastewater (Art. 137°), the technical opinion from the sectoral environmental authority (Art. 138°), expiration of licenses (Art. 143°), grounds for revocation of discharge licenses (Art. 144°). It also dedicates importance for the reuse of wastewater (Art. 147°), conditions to get licenses to reuse treated wastewater (Art. 148°), license terms (Art. 150°) and the monitoring and control of treated wastewater (Art. 152°).

Sanitation General Act - 'Ley General de Saneamiento (Ley N° 26338)'

This Act establishes the rules governing the provision of sanitation services, which include the regular provision of services of potable water, sanitary and storm sewers and sanitary excreta disposal, both in urban and rural areas.

Consolidated Text of the Regulations of the General Law of Sanitation Services - 'Texto Único ordenado del Reglamento de la Ley General de Servicios de Saneamiento (D.S. N°023-2005-VIVIENDA)'

This regulation governs the application of the General Law of Sanitation Services and includes provisions relating to:

a) The conditions for the regular provision of sanitation services.

b) The functions, attributions, responsibilities, rights and obligations of entities related to the provision of sanitation services, and the rights and obligations of users.

c) Corporate regimes, tariff regulation, the private sector participation and the use of public property and third parties for the provision of sanitation services.

Organic Law of Municipalities - 'Ley Orgánica de Municipalidades (Ley N° 27972)'

Art. 80° of this Law describes the obligations, and responsibilities of municipalities in terms of sanitation, salubrity and health.

Some of the most specific regulations in terms of discharge permissible ranges and implementation of discharge programs are outlined below:

- Maximum Permissible Limits for Effluents from Domestic and Municipal Wastewater Treatment Plants - '*Límites Máximos Permisibles para los Efluentes de Plantas de Tratamiento de Aguas Residuales Domésticas o Municipales (D.S. N° 003-2010-MINAM)*'
- Maximum Admissible Values from the discharge of non-domestic wastewater in the Sanitary Sewage System - '*Valores Máximos Admisibles (VMA) de las descargas de aguas residuales no domésticas en el Sistema de Alcantarillado Sanitario (D.S. N° 001-2015-VIVIENDA)*'
- Measures for the Implementation of the Dumping Adjustment and Wastewater Reuse Programme - '*Medidas para la Implementación del Programa de Adecuación de Vertimientos y Reúso de Agua Residual - PAVER (R.J. N° 274-2010-ANA)*'

6.2.2 Health Legislation and Considerations

Bylaw of Organisation and Functions of the Health Ministry - 'Reglamento de Organización y Funciones del Ministerio de Salud'

Art. 50 specifies that the Department of Ecology and Environmental Protection is responsible, among others, for the following functions:

- Monitoring the quality of resources, water, air and soil to identify risks to human health.
- To design and implement the system of registration and control of discharges in relation to their impact on the receiving water body; as well as the registration and control of pesticides and disinfectants for domestic, industrial and public health use.

Art. 51 indicates that the Directorate of Basic Sanitation is responsible, among others, for the following general functions:

- To establish sanitary technical standards for water supply for human consumption; for management, reuse and discharge of domestic sewage and excreta disposal; for solid waste management; and for surveillance and control of transmissible diseases arthropod vectors and pests of public health importance, under current regulations.
- To monitor the sanitary quality of water and sanitation systems for the protection of the population health.

6.2.3 Economic Legislation and Considerations

Water Resources Act – 'Ley de Recursos Hídricos (Ley N° 29338)'

The Water Resources Act regulates the economic regime of water use and establishes that holders of rights of use are required to contribute to the sustainable and efficient use of water resources by paying the Economic Compensation and Tariffs relating to them.

Art. 15° of this Law mandates that the National Authority is responsible for elaborating the method and determining the value of Economic Compensation for the right to water use and for discharging wastewater into natural water sources, values that must be approved by supreme decree; and also for approving Tariffs for use of hydraulic infrastructure, proposed by hydraulic operators. Likewise, it is responsible to grant, modify and extinguish, with a prior technical study, water use rights, and approve the implementation, modification and termination of rights of water use through decentralised organs of the National Authority.

The economic-financial conditions under which the supply of water services is produced comprise two large blocks, as required by Art. 90° to 96° of Title VI, "Economic regime for the use of water":

- Economic Compensation for water use and Economic Compensation for wastewater discharge.
- Tariff for the service of water distribution in sectoral uses; tariff for the use of major and minor hydraulic infrastructure; and tariff for monitoring and management of groundwater use.

The value of these payments is determined through a separate calculation methodology for each of them. Economic compensation is determined by each Administrative Authority of Water (AAA) using a methodology approved by the National Authority of Water (ANA). Meanwhile, to calculate the Tariff, the ANA has to develop a calculation methodology. Until approved, the law allows to set a financial reward based on previous experiences, with certain increases established by Supreme Decree.

The collection of 2012 was estimated at US$ 17 million, which are distributed as follows:

- Economic Retribution from non-agricultural use ≈ US$ 11 million.
- Economic Retribution from agricultural use ≈ US$ 3.2 million.
- Economic Retribution from groundwater ≈ US$ 0.5 million.
- Dumping of wastewater ≈ US$ 2.1 million.

With this level of financial retribution, it is clear that the goal set by the Water Resources Act (Art. 95°) is not being reached. Hence, Economic compensations are planned to be increased substantially and progressively to achieve that goal.

Water Resources National Plan of Peru – 'Plan Nacional de Recursos Hídricos del Perú (PNRH)' - 2013

The Water Resources National Plan (PNRH) requires, as part of the fulfillment of its objectives and realisation of programs, an investment of approximately US$38,546.915 for the implementation of tailored programs, with two planning horizons with an investment of 49% at the beginning and 51% to be implemented between 2021 and 2035. Whereupon among several others objectives, the aim is to plan water management to balance and harmonise supply and demand, in order to protect their quantity and quality and provide efficient use to contribute to local, regional and national development and strengthen the economic regime for wastewater use and dumping.

Water Resources National Policy and Strategy - 'Política y Estrategia Nacional de Recursos Hídricos (PENRH)' - 2015

The Water Resources National Policy and Strategy (PENRH) is presented to the public in compliance with Articles 66°, 67° and 69° of the Political Constitution of Peru (Constitución Política del Perú) and in accordance with the legislation that regulates water resources. It handles different investment policy axes. The most relevant, in the project interest, are described below:

- Policy axis: 'Quantity Management'

Emphasizes the conservation of ecosystems and hydrological processes on which national water resources supply depend, as well as fosters efficient use of water resources, so that supply and demand of water resources can be balanced and harmonised to water multiple uses.

- Policy axis: 'Opportunity Management'

It addresses in a timely manner, the demand for water resources by respecting the principle of legal certainty; enhancing its inclusive, temporal and spatial distribution; and promoting universal access to drinking water. One of the main intervention strategies for this axis includes: Developing an economic regime for water use and treated wastewater dumping, in order to improve water resources integrated management.

To date, it can be estimated that the annual costs for the proper operation and maintenance of the 163 Wastewater Treatment Plants (WWTPs) handled in Peruvian territory is approximately US$ 26 million per year, this equates to approximately;

- ponds: 1.15 US$/year per capita;
- trickling filters: 2 US$/year per capita;
- activated sludge: 6 US$/year per capita).

6.2.4 Conclusions

Peru has a well-developed legislative infrastructure, however is currently struggling to fund the installation of appropriate sewerage and sanitation. There are currently 163 WWTP's in Peru costing US$26million to operate and maintain.

More money is required to install additional cost effective wastewater treatment, this is expected to be sourced from provider fees, local development and public private partnership.

6.3 Ecuador

Ecuador is a country where biodiversity and natural environment are a very strong asset. Hence the country has developed a complete set of laws aiming at the protection of this natural heritage. It includes legislation about water issues, even if in this case a lot of improvements remain to be done.

The First text in Ecuador referring to water is the Constitution. Ecuador was one of the first countries in the world to integrate rights regarding nature in its constitutional framework. The last version was written in 2008 and included one article dedicated to the right to water:

Art. 12.- El derecho humano al agua es fundamental e irrenunciable. El agua constituye patrimonio nacional estratégico de uso público, inalienable, imprescriptible, inembargable y esencial para la vida.

And another article is describing the right to a healthy and balanced environment, looking for environmental preservation:

Art. 14.- Se reconoce el derecho de la población a vivir en un ambiente sano y ecológicamente equilibrado, que garantice la sostenibilidad y el buen vivir, sumak kawsay. Se declara de interés público la preservación del ambiente, la conservación de los ecosistemas, la biodiversidad y la integridad del patrimonio genético del país, la prevención del daño ambiental y la recuperación de los espacios naturales degradados.

Another important text is the “national plan for good life” (*Plan nacional del buen vivir*). Mainly designed as a political program in 2009 by the actual government (following the national plan for development proposed by the same government during its first mandate from 2007 until 2010), it is now followed as a political guide by the actual majority to reach “quality of life” through a complete set of objectives and political orientations. The first version of 2009 was replaced by a second version for the period 2013-2017. Its 7th Objective is dedicated to the right of nature and sustainability (“*Garantizar los derechos de la naturaleza y promover la sostenibilidad ambiental, territorial y global*”). Objective 7.6 focus especially on the sustainable and participatory management of the water heritage. It specifies, regarding waste water management in its g section: “To set a record of wastewater downloads for each sector and affluent, in order to regulate, control and sanction pollution of water resources and to develop specific actions for treatment and quality water delivery.” Objective 7.8, dedicated to environmental pollution, also specifies: “To strengthen and encourage water treatment for household, industrial, agriculture and mining uses in order to reduce pollution in the download sites and meet with the rules, regulations and standards of environmental quality.” It integrates as a general objective to reduce by half the amount of non-treated wastewater by 2030. It also specifies in its general objectives to amplify international collaboration for a better capacity in solving water issues, waste treatment being one of them.

More recently in January 2016 these objectives were integrated into a document emitted by the Ministry of water (SENAGUA): “national strategy for potable water and sanitation, phase 1: diagnostic, priority, strategies and program proposals (ENAS)”. It integrates plans for water issues financing, decentralisation, investment, services, investors’ solvability and implementation capacity from the institutions.

To apply these general political objectives and constitutional rights, the following texts were defined:

- Ley de gestion ambiental (2004)
- Ley de prevención y control de la contaminación ambiental (2004)
- Ley orgánica de recursos hídricos, usos y aprovechamiento del agua (LORHUAA)
- Código organico de salud
- TULAS (Texto Unificado de Legislación Ambiental Secundaria) y TULSMA (texto unificado legislación secundaria, medio ambiente)
- TULAS, Libro VI, Anexo 1: norma de calidad ambiental y de descarga de efluentes : recurso agua

6.3.1 Environmental Legislation and Considerations

Environmental management act - Ley de Gestion ambiental

The Environmental Management Act is the most important legal text dedicated to environmental protection in the country. This law is directly related to the prevention, control and sanctioning of activities polluting natural resources. It establishes the guidelines for environmental policy and determines the obligations and levels of participation of the public and private sectors in environmental management. It also identifies the permissible limits, controls and sanctions in this field.

The enactment of the Environmental Management Act in the year 1999, confirmed that the Ministry of Environment, created in 1996, is the national environmental authority and established a general framework for the development and approval of environmental regulations, within the principles of sustainable development established in the Rio Declaration about Environment and development, and ratified in the national constitution.

Decentralised Environmental Management System is established as a mechanism for cross-sectoral coordination, interaction and cooperation between the different areas, systems and subsystems of the environmental management and natural resource management.

It provides that the Ministry of Environment, meanwhile, should coordinate with relevant agencies control systems for verification of compliance with environmental quality standards relating to air, water, soil, noise, waste and pollutants. On the other hand, states that public,

private or mixed works and projects of public or private investment that may cause environmental impacts, should prior to execution be qualified by decentralised control bodies, as the Unique Environmental Management System.

This Act and its Regulations for the Prevention and Control of Environmental Pollution, are applied in what has to do with water resource through the effluent discharge standards defined in Book VI, Annex 1 of the Unified Text Secondary Environmental legislation (TULAS, presented hereafter).

The Law on Prevention and Control of Environmental Pollution - Ley de Prevención y Control de la Contaminación Ambiental

This law aims primarily to control and prevent the pollution of water, air and soil resources. With the enactment of the Environmental Management Act, the Law on Prevention and Control of Environmental Pollution has repealed several of its provisions, since the Environmental Management Act expressly repealed many of its articles. However, the other provisions remain in force but with the limitations of a law passed almost thirty years ago, which in practice did not become the most effective tool to combat environmental pollution because it was not functional. For example the Environmental Protection Agency Committee was established but actually rarely met and could not become the governing body of these policies as intended by the law.

Originally the Ministry of Health was the competent authority at the national level to enforce its provisions because it was a time when pollution problems were attended from the perspective of public health. Currently, the regional governments are the competent authorities and the Ministry of Environment in cases that no delegation or decentralisation process in environmental matters.

The Health Code, the Water Act, the Maritime Police Code and other laws governing on air, water, soil, flora and fauna are supplementary to this Act.

Organic law about water resources and use - Ley orgánica de recursos hídricos, usos y aprovechamiento del agua (LORHUAA)- 2014

This act defines the national system for water management and the “unique water authority” with the respective competences of each body. Hence further to the Ministry of Environment, defining the laws and great political directions, water authorities at national level are threefold:

- Secretaria Nacional del Agua - SENAGUA
- La Empresa Pública del Agua - EPA
- La Agencia de Regulación y control del Agua – ARCA

Water planning process and responsibilities is also specified, as well as the management of water resources, the obligations as public services and the responsibilities of decentralised autonomous governments relative to water issues.

Further to these organisational aspects, it specifies the rights to water in the country in terms of service, quality, prices, access and equality and whether those rights apply to human, to nature and to consumers.

It finally describes prevention and control strategies as well as the different rules applying for each use of water in the country.

Regarding wastewater, articles 80, 81 and 82 mention:
"Discharges: prohibitions and control. They are considered as discharges wastewater discharges that are made directly or indirectly in the public water domain. Direct or indirect discharge of water or waste products, sewage and untreated water that may contaminate public water domain is prohibited. National Environmental Authority shall control discharge in coordination with the Authority of Water and accredited autonomous governments in the unique environmental management system. The treatment of wastewater and solid waste, to avoid contamination of waters in accordance with the law, is the responsibility of municipal autonomous governments."

"Administrative authorisation of discharges. The authorisation for downloads will be included in the environmental permits issued for the effect. The parameters of the quality of water being poured and the procedure for the granting, suspension and review of the authorisation, shall be governed by the National Environmental Authority or accredited in coordination with the Central Water Authority. Decentralised Autonomous Governments in the field of their competence and within its jurisdiction will issue administrative discharge authorisation under this Act subject to public policies issued by the National Environmental Authority."

"Participation and citizen oversight. People and social groups can perform oversight processes, observatories and other mechanisms of social control over water quality and plans and programs for prevention and control of pollution, in accordance with the law."
TULAS: Texto Unificado de Legislación Ambiental Secundaria -Unified Text of the Secondary Environmental Legislation
The Unified Text of the Secondary Environmental Legislation was published in the year 2003. It unifies the secondary environmental legislation to ease the access to the required standards for citizens. It is a fairly broad regulatory text of the current Ecuadorian legislation in the Environmental Management Act and what remains into force of the Law on Prevention and Control of Environmental Pollution. It is, therefore, a detailed legal development tool at the regulatory level of legislation related to environmental issues in general, environmental impacts, forestry and related arrangements, etc.

The consolidated text is composed of nine books, some of them with specific annexes:

- Book I: Environmental Authority;
- Book II: Environmental Management;
- Book III: Forest System, Annex 1: Determination of restoration value, Annex 2:

Conceptual Guide of methods for assessing environmental damage, Annex 3: Form for data presentation about areas to be declared protected forest and vegetation;

- Book IV: Biodiversity, Annex 1: List of endangered bird species in Ecuador;
- Book V: Coastal Resources;
- Book VI: Environmental Quality, Annex 1: Statement of environmental quality and effluent discharge: water resource Annex 2: Environmental quality standard of soil resources and criteria remediation for contaminated soils, Annex 3: Standard Air Emissions from stationary combustion sources, Annex 4: Standard ambient air quality, Annex 5: permissible limits of ambient noise levels for fixed and mobile sources, and vibrations, Annex 6: environmental quality standard for the handling and disposal of non-hazardous solid waste, Annex 7: national Listings of banned chemicals, hazardous and severely restricted use to be used in Ecuador;
- Book VII: Special Regime: Galapagos;
- Book VIII: Institute for Amazonian Regional Eco-development (ECORAE);
- Book IX: System of laws or fees for services provided by the Ministry of Environment for the use and exploitation of domestic goods that are under their care and protection.

Book VI is dedicated to environmental assessment, detailing the rules and processes required for the realisation of impact studies. Its annexes specify the detailed technical values for various types of issues: air, water, soil, noise, chemicals, waste, etc. Annex 1 is dedicated to water, it is presented in the next paragraph.

Adopted in 2015 TULSMA (*Texto Unificado Legislación Secundaria, Medio Ambiente*) is a new text replacing part of the existing TULAS text, especially book VI. It has no effect actually on legislation regarding water treatment.

TULAS, Libro VI, Anexo 1: norma de calidad ambiental y de descarga de efluentes: recurso agua – Environmental quality and effluent discharge standard: water resource

This environmental technical standard is issued under the aegis of the Environmental Management Act and the Environmental Management Act for the Prevention and Control Environmental Pollution and subject to the provisions thereof. It sets mandatory rules applicable throughout the whole national territory.

This technical standard determines or sets:

- The permissible limits, provisions and prohibitions for discharge into bodies water or sewerage systems;
- The criteria of quality of water for its various uses;
- Methods and procedures for determining the presence of contaminants in the water.

The standard aims at the prevention and control of environmental pollution with regard to water resources. Its main objective is to protect the quality of water resources for preserving the integrity of people, ecosystems and their interrelationships and the environment in general.

Actions to preserve, maintain or recover the quality of water resources shall be carried out under the terms of this standard.

On the basis of a set of potential uses for water it defines the technical limits for water quality of each uses:

- Water for drinking
- Water in natural wet or marine areas
- Underground water
- Water for agriculture
- Water for livestock
- Water for entertainment
- Water for aesthetic use
- Water for transportation
- Water for industrial use

Regarding wastewater, it gives rules for effluents discharge in the public network and in natural water bodies.

This document was modified in 2015 according to the ministerial agreement number 079, defining new limits for effluent discharge. These rules are presented in ANNEX together with the chemical values considered for water quality assessment in each case.

Technical standards regarding effluents

Two local standards are mentioned in the Annex 1 of TULAS book VI for water related practice, actually for quality measurements:

- *NORMA TÉCNICA ECUATORIANA: INEN 2 169: 98. Calidad del Agua. Muestreo. Manejo y conservación de muestras.*
- *NORMA TÉCNICA ECUATORIANA: INEN 2 176: 98. Calidad del Agua. Muestreo. Técnicas de muestreo.*

6.3.2 Health Legislation and Considerations

As mentioned in ENAS (National strategy for potable water and sanitation), the Ministry of Public Health, which is the entity in charge of monitoring water quality, performs localised efforts that do not lead to a national aggregation nor generates statistics that allow monitoring and decision making. Its control in most cases is reactive to complaints or outbreaks of waterborne diseases. The recent institutional changes for this sector, where the Hygiene Institute Izquieta Perez gave way to the creation of the Agency for Health Regulation and Control (ARCSA), so far have not led to improvements in this regard, it has even been diluting this responsibility.

In March 2016 the new “health code” was presented, this is the legal basis for the organisation and practice of all health related issues and rights in Ecuador.

Article 100 specifies the authorities in charge of defining standards and rules for effluent discharge in order to respect human health. Article 101 repeat which are the authorities (the decentralised autonomous governments) in charge of the monitoring and follow up of effluents discharge permits.
Article 103 specifies that housing, schools, industries, retails, services and other buildings have to use the public water collection network for their wastewater. If there is no network, they have to request a permit of discharge after a treatment process in conformity with the current standards. *It specifies that the state will promote ecological sanitation solutions.*

Article 104 specifies that every industrial, commercial, public or private service building has the obligation to install sanitation systems to treat waste water produced from its activity. It has to comply with the current standards to be able to discharge this water in the public collection network or in natural water bodies.

6.3.3 Economic Legislation and Considerations

The national strategy for water and sanitation (ENAS) mentions the following investment plan:
"With the goal of achieving universal coverage of potable water and sanitation in urban and rural areas of the country, as well as the treatment of all the wastewater of the ten major urban areas, ENAS-Phase I raises investments of approximately US $ 7,300 million in the period 2015-2024. From this total, US $ 2,400 million would be earmarked for water and US $ 4,900 million would be invested in sanitation, including wastewater treatment."

However, in the same ENAS it is mentioned that the financial capacity of the local government may not be sufficient to assume these objectives. It was planned that they could refer to the national entities to complete their financing requirements, however the recent strong crisis in the country compromises this ambition.

The LORHUAA law (chapter IV - Economical rules) plans the introduction of a tariff system for raw water aiming at encouraging efficient use of water, discouraging excessive consumption, waste, and other operating losses and encouraging savings and conservation of the water. In the case of water use for domestic supply, the Law plans the establishment of a vital minimum consumption, in order to define the volumes to be delivered to providers of free service cost to fulfil the human right to water.
The following articles are the most interesting:
Article 135. General criteria for water rates.
(...) The rates for the provision of potable water, sanitation, irrigation and drainage shall be determined by both public providers and community respectively, on the basis of regulations issued by the Central Water Authority through the Agency for Regulation and Control.
Article 136. General principles for setting water rates.

In establishing fees for authorisation of use and water use as well as potable water, sanitation and irrigation and drainage services, the principles of solidarity, equity, sustainability and periodicity have to be considered.

Article 139. - Rate for basic public services.

Basic public services are defined as drinking water supply, sanitation, irrigation and drainage utilities.

The setup of tariffs is competence of public providers of such services or community agencies that provide it legitimately on the basis of the regulations of the Central Water Authority.

The establishment of tariffs will consider the following criteria:

a) Inclusion of proportional form of what the owner of the service must pay to the Central Water Authority for the raw water supply;

b) Inclusion proportionally of the cost of collecting, handling, drive, conduct, operation, treatment, management, asset depreciation, amortization, distribution, environmental sanitation and new investments for water supply.

In any case, the service tariffs will be differentiated and consider the socio-economic situation of people with lower income and disability status of consumers.

6.3.4 Conclusions

Although Ecuador has so far only reached a low level of waste water treatment across the country, it has a complete set of both ambitious and demanding laws regarding water. The political willingness is increasing as the country is perceiving the importance of the natural heritage in terms of biodiversity preservation, quality of life and above all tourism attractiveness capacity. It lead to important political actions like the modification of the constitution and the reorganisation of the water sector.

Nonetheless the decentralisation of responsibilities towards local municipalities regarding sanitation does not help for a strong development of infrastructure coming from the public sector as most of the local bodies face important difficulties either for managing important project and financing them. Hence today most of the waste water is rejected without any treatment in water bodies, and most of the investments dedicated to sanitation were focused on sewer construction without waste water treatment plant at the output.

The increasing environmental understanding gives birth to interesting initiatives, starting first in the largest cities, much more organised and financially powered than the others like the construction of first experimental infrastructures. The recent legislation voted in Quito, allowing an increase of the right for construction (in terms of area) when respecting eco-efficiency rules, including water treatment issues, is also a strong step towards the use of new tools to promote win-win relationship between public and private sector in construction and city planning. It should give a true opportunity for decentralised sanitation providers to propose their solutions directly to the private sector.

7 Others

7.1 India

The 12th Five Year Plan of India notes that the "2030 Water Resources Group (2009) estimates that if the current pattern of water demand in the country continues, about half of the demand for water will be unmet by 2030[115]". As cities and rural areas develop, water stress increases as does wastewater generation. Treatment and reuse of municipal wastewater provides an opportunity not just for improved public health and environment but also to meet the increasing demand for water of different economic segments. Though the potential for municipal wastewater treatment and reuse in India is high, there are various challenges linked with it. These include limitations of space (especially in the urban context), cost constraints, achieving performance standards, being climate compliant, high operation and maintenance requirements, skilled personnel and electricity dependency (though weakening). To advance the municipal wastewater treatment and reuse market, investments need to be made on technologies that can overcome these challenges to scale up and succeed.

As reported in a newspaper article, the Central Pollution Control Board (CPCB) of India, has said that 63% of all sewage flowing into rivers every day is untreated in urban centres[116]. Out of 62,000 million litres per day (MLD) of sewage generated, the centralised treatment capacity developed so far is only 23,277 MLD from 816 sewage treatment plants spread across the country (Times of India, Sep 26, 2016). Water quality monitoring carried out by CPCB indicates that more than 600 urban centres in the country are not meeting the water quality criteria with respect to BOD (Biological Oxygen Demand) and faecal coliform bacteria.

India with a GDP growth of 7.6% (2015-2016) is an attractive investment destination due to its dynamic market, cost advantage and technological competencies. With the Swachh Bharat Mission (Clean India Mission, launched in 2014) facilitating building of toilets, the potential demand for sewage treatment has increased exponentially.

Typically, in a city or town, a combination of centralised, decentralised and on-site wastewater management systems exists. The current trend in India is towards 'ecological technologies' as well as decentralised sanitation systems as centralised sewer networks and sewage treatment plants are not easily implementable in fast developing small towns and peri-urban areas of larger cities. Also reuse of treated wastewater from centralised systems has not been very successful due to challenges associated with conveyance of treated wastewater to the point of reuse.

[115] *Planning Commission, 12th Five Year Plan (2012/2017), Government of India, 2013, 178*
[116] *Times of India, September 27, 2016*

A landscape assessment study[117] indicates water stress and legal mandate as the main drivers of installation of decentralised or on-site wastewater management systems. The potential market segments for decentralised and on-site systems identified in the study mentioned above, were, private villas, apartment blocks, gated communities, IT parks, schools, hospitality sector, educational institutions and hospitals.

Increased public awareness, opening of the market and its robustness, environmental pressures, increasing demand on water resources due to increasing population pressure and increasing government support is assisting the shift towards green technologies that allow for reuse options. Assessment of sector stakeholders' requirements highlights the need for continuous supply of 'treated' wastewater that is safe for reuse at a financially viable cost. Therefore, technologies that are legally and environmentally confirming, can maintain the performance requirements over time, whose operations are safe and simple, are not energy intensive, are capable of attracting fiscal incentives set by the Government and are commercially viable as well, have a high market potential in India.

The concept of wastewater treatment and reuse and the need to include the same in all water supply and wastewater management programs is recognised by most policy frameworks in India. The implementation and enforcement of wastewater treatment has been well established though not to the required levels. However, reuse enforcement is lagging behind. This is mainly due to a lack of detailed guidance on treatment standards, types of reuse applications, design and O&M considerations for management of wastewater recycle projects and tariff structures for sale of recycled wastewater for various applications. Initiatives have been taken at state and city levels but not under a national framework. At present, the available legal and regulatory frameworks to be followed for wastewater treatment are well defined and structured; for wastewater recycle and reuse for various applications, there are national and international guiding frameworks. This includes the guidance provided in the recently revised and updated Manual on Sewerage and Sewage Treatment Systems (CPHEEO, 2013, Part C, Chapter 2), the WHO's guidelines, first published in 1989 and revised in 2006 and the USEPA (2012) water reuse guidelines.

7.1.1 Environmental Legislation and Considerations

Wastewater treatment in India has been addressed under the ambit of environment protection and pollution prevention and control. Legislation and standards have been defined to ensure that pollution can be controlled and prevented in rural and urban areas. Implementation and enforcement of legislations has been assigned to various institutions as described in the following paragraphs. Legal provisions for wastewater treatment and reuse are described subsequently.

[117] *CDD Society, Strengthening the Operation & Maintenance Sector for Servicing Decentralised Urban Sanitation infrastructure in Bangalore, 2015, 33*

In India, there are three levels of execution of established water/water-related policies – at the central, state and city/local government level. Water is a State subject (Constitution of India, Article 245). The pollution and prevention of it is dealt by the State Pollution Control Board[118] based on the laws that have been framed by the central government and, if required, made more stringent by the State. Each State manages, controls and administrates the use of it. There are different institutions assigned with different tasks as dictated by the Water Policy of the State.

To oversee the implementation of environmental and forestry programs, the Ministry of Environment and Forests (MoEF) was formed in 1986. It is a nodal agency for the planning, co-ordination and overseeing of environment and forest issues. The principal activities undertaken are the conservation of natural resources, protection of the environment and the framework of legislations.

In order to implement the Water (Prevention and Control of Pollution) Act, the Central Pollution Control Board (CPCB), a statutory organisation, was constituted in September 1974. The CPCB functions as an autonomous institution under the MoEF. It serves to provide technical services to the MoEF with its principal functions being as spelt out in the Water and Air Acts. They also carry out research studies. They provide technical assistance and guidance to the State Boards. They collect, compile and publish technical and statistical data and the measures devised for the effective prevention, control or abatement of water or air pollution. They also lay down, modify or annul, in consultation with the State Governments concerned, the standards for water and air quality. The State Government has the authority to make the standards stricter but they cannot ease the standards and this process, if implemented, has to be duly notified with reasons. The CPCB also lays down standards for treatment of sewage and trade effluents; and has evolved efficient methods for disposal of sewage and trade effluents on land in addition to developing reliable and economically viable methods of treatment of sewage, and industrial effluent pollution control equipment. The State Pollution Control Board, with respect to water treatment, has the power to inspect effluents, works and plants, to review plans, specifications or other data relating to plants setup for the treatment of water, works for purification thereof and the system for disposal of sewage or trade effluents. They also have the powers to evolve economical and reliable methods of treatment of sewage with regard to the peculiar conditions of soils, climate and water resources of different regions and more especially the prevailing flow characteristics of water in streams and wells. For implementing a wastewater treatment plant, consent has to be applied to the State Pollution Control Board regional office. This consent application (commonly referred to as the Consent for Establishment – CFE) has to include the design details and drawings. The treatment plant can be constructed only after and as per the Board's approval. The design is approved only on the basis of the technology, treatment capability and disposal plans being approved. For an apartment building, the developer will have

[118] *GIZ-India, Legal and policy framework for wastewater treatment and reuse in India: a background review, 4*

to apply for the consent; and for a community group, the group representatives will have to apply for the consent.

Water and sanitation also come under the purview of the Ministry of Urban Development (MoUD) at the central government level. It is the apex department in the sector which coordinates urban sanitation activities across the country. At the state level, the Urban Development Department (UDD) is the agency responsible for water and sanitation as a component of the development and planning for cities and towns. It has a number of local bodies functioning under it. Through the 74th Constitutional Amendment, enacted by the Parliament in 1993, the State is mandated to transfer responsibility of water supply and sanitation (WSS) services to urban local bodies (ULBs) such as Nagar Panchayat (City council), Nagar Palika (Municipality) and Nagar Nigam (Municipal Corporation) in the ascending order of magnitude. This amendment is aimed at strengthening ULBs through devolution of powers towards decentralisation. The Directorate of Municipal Administration (DMA) heads these local bodies. The local governments/ULBs are mandated to undertake planning, design, implementation, O&M of water supply and sanitation services within their respective jurisdictions including Public Sanitation, which translates to solid waste and sewage management. The Ministry of Urban Development at the Centre or the Department of Urban Development at the State level deals with sewage from cities but not from industries. These come under the pollution control boards, even the domestic effluents from industries. The State Urban Water Supply and Sewerage Boards look after urban areas of different districts with populations of more than 20,000 people. For populations of less than 20,000 people, the Public Health and Engineering Departments come into play. These institutions look after the water supply and sewerage maintenance and revenue collection for the same, for areas connected to the supply and sewer lines. Monitoring of supply and sewage lines is done by the State Pollution Control Boards.

For rural areas in the country, Ministry of Drinking Water and Sanitation, its State departments and the Pachayats at the village level are responsible for sanitation and wastewater treatment. Institutional roles are depicted in Table 45[119] below:

[119] *CDD Society, 2015, Strengthening the Operation & Maintenance Sector for Servicing Decentralised Urban Sanitation infrastructure in Bangalore,17*

Table 45: Institutional roles with respect to wastewater

No.	Functions	Institutions formally Responsible	Relative Importance of Institutions
1	Policy and Standards-setting	National and State Governments (MoEF/Urban Development/Public Health Engineering Department), Bureau of Indian Standards, Pollution Control Boards	Technical and environmental standards set at national level provide over-arching framework
2	Financing of Capital Investments	National and State Governments (PHED/UD)	National Schemes main funding source; few states/cities invest from own budgets
3	Asset Creation	PHEDs/Parastatals/ULBs	Mainly done by PHED/parastatals
4	O&M Management	PHEDs/Parastatals/ULBs	Mainly by PHEDs/Parastatals in small towns and town panchayats and by ULBs in bigger cities
5	Monitoring and Evaluation	GoI, State Governments (PHED/UD); and ULBs for towns/cities, Bureau of Indian Standards, Pollution Control Boards	Scheme M&E carried out by GoI, and ULBs when implementing schemes
6	Regulation	State Departments (UD/PHE and Pollution Control Boards)	State UD/PHE (for technical) and PCBs (for environmental outcomes)

In order to prevent and control pollution, legislations for wastewater treatment and disposal or reuse have been developed and are being implemented. Sector specific policies like the National Urban Sanitation Policy 2008, Urban Development policies of different states, Draft National Water Policy 2012, govern infrastructure creation and services linked to it - like operation, maintenance as well as involvement of the private sector. Regulation of the quality of drinking, surface and ground water as well as for effluent and sewage is carried out through a set of standards. As described in the Report, Water and Wastewater in India, EBTC, 2011[120], "these are national and therefore mandatory standards, such as for drinking water (IS 10500-1991) or for water quality for irrigation of agricultural land (IS 11624-1986) and are subject to

[120] *European Business and Technology Centre, 2011, Snapshot, Water and Wastewater in India, 4*

many different norms adopted by rural local and urban bodies. However, the most central water quality standard in India is the Bureau of Indian Standards (BIS-IS:10500) which was implemented not only to assess the quality of water resources but also to check the effectiveness of wastewater and water treatment and the provision of all involved authorities."

Wastewater regulation is reflected in policies (National Environment Policy, 2006 and National Sanitation Policy, 2008) as legal provisions and framework guidelines. The NUSP mentions that all human excreta and liquid wastes must be disposed off safely (p8, NUSP, 2008). The regulatory process is carried out through various environmental laws such as:

- The Water (Prevention and Control of Pollution) Act, 1974
- The Water (Prevention and Control of Pollution) Rules, 1975
- The Water (Prevention and Control of Pollution) Cess Act, 1977
- The Environment Protection Act, 1986
- Hazardous Waste (Management and Handling) Rules, 1989
- Municipalities Act; District Municipalities Act

The Water (Prevention and Control of Pollution) Act, 1974, restricts discharge of untreated wastewater and has defined discharge norms for sewage and industrial effluents. Industries and local bodies are mandated to treat wastewater to the defined standard levels before discharge. Standards have been defined for 33 parameters for different discharge points categorised as discharge on land for irrigation, in public sewers, in inland surface water bodies and in marine coastal areas. The Pollution Control Boards have been mandated to monitor and enforce these directives. The Water (Prevention and Control of Pollution) Cess Act of 1977 established a levy on industries using water; this levy funds the resources of the Pollution Control Boards to deliver their responsibilities. The Environment Protection Act, 1986, provides for audit of all units that need permits for establishment and operation under the various Acts/Rules.

Based on a MoEF notification dated September 14, 2006[121], which states that all projects occupying an area of more than 20,000 sq.m. need an environment clearance including provision for wastewater treatment, States and their PCBs have issued notifications for establishing on-site sewage treatment facilities. Consent to establish and to operate wastewater treatment systems is provided by the State Pollution Control Boards based on the categorisation (red, orange and green) of wastewater generators as defined by the Environment Protection Act.

In Karnataka, a state in south India, the Karnataka State Pollution Control Board (KSPCB) has mandated STPs for apartments > 5,000 sq.m or > 50 units (and only for new construction projects) (Evans et al. 2014). KSPCB also insists on zero liquid discharge[122] (ZLD) and reuse of all treated water on-site and dual plumbing to reuse treated water for flushing, a necessity to

[121] *MoEF, GoI, EIA Notification, 2006*
[122] *Evans, AEV, S Verma and A Krishnamurthy (2014), Formal approaches to wastewater reuse in Bengaluru, 3*

grant consent for establishment (CFE). The latest Government of Karnataka (GoK) Forests, Ecology and Environment (FEE) notification mandates establishment of STPs for all residential complexes of more than 20 units[123] (not just new projects) (GoK FEE 2016).

The State of Karnataka has been actively addressing some of the issues/challenges raised by construction companies/citizens with respect to the notification. For example, FEE[124] has exempted projects < 20,000 sq.m from installing on-site STPs if there is underground drainage network. (GoK FEE 2009). The details for consent for the establishment of decentralised wastewater management systems for domestic sewage is highlighted in Table 46Table 46 below. These systems need to submit performance reports to the PCB every year to renew their consent to operate. Systems found to be non-performing are closed down. Industries follow the Zero Liquid Discharge (ZLD) Policy. Wastewater generators have to treat the wastewater up to a level where it can be reused (based on standards and guidelines provided by the PCB) within the campus.

Table 46: Consent to establish (non-industry) as mandated by Karnataka SPCB

Types of establishment	**Category requiring consent**
Commercial Buildings (Hotels, Commercial Complexes) in sewered area	Built up area > 20,000 sq. m
Commercial Buildings in non-sewered area	Built up area > 2,000 sq. m
Institutional Buildings (Educational Institutes, Hospitals, Prison)	Built up area >5,000 sq. m
Townships and Area Development Project	Total area >= 10 acres
Residential Units in sewered area	Built up area > 20,000 sq. m
Residential Units in non-sewered area	>20 units or Built up area >2,000 sq. m

In addition to the above Acts, the following Standards and Building Codes are relevant to the design, provision and operation of decentralised wastewater treatment systems:

- National Building Code of India (Bureau of Indian Standards, 2005)
- Indian Standard Code for basic requirements for Water Supply, Drainage and Sanitation (Bureau of Indian Standards, 1993)
- Building Bye-laws (State/City specific)
- Manual on Sewerage and Sewage Treatment Systems (CPHEEO, 2013)

[123] *BWSSB, 2016, Adoption of dual piping in apartments with more than 20 units*
[124] *GoK FEE (2009) Notification on exempting construction projects in sewered areas from consent process of KSPCB*

The Codes and Standards, as mentioned above, include detailed sections on designing of systems (basically covering only septic tanks); however, there is little or no mention of the standard procedures to be followed for operating the same. The Building Bye-laws for cities have relevant sections on planning and designing of only conventional sewerage systems.

The policies and regulations are quite comprehensive and are apt for improving the environment and pollution abatement. However, the incremental approach, as recommended in the NUSP 2008, and the strict standards, at times, does not match with each other as towns and cities grapple with balancing environmental needs with social and financial constraints. Some of the regulations also seem to have limitations like the ZLD directive that is difficult to adhere to as most of the times apartments or housing layouts are not able to utilise all the treated wastewater within their campus and there are no provisions that list what to do with excess treated wastewater. In addition, the implementation and monitoring of these legal provisions is still lagging behind. This gap can be attributed to the operation of multiple agencies, varied structures and tools in different states, overlapping responsibilities and inadequate capacities with the agencies for effective and efficient implementation.

In the increasing water scarcity scenario in India, wastewater treatment and reuse is endorsed and supported in national policies and laws. The National Water Policy [125](2012) recognised reuse as a significant factor for meeting environmental objectives and recommends preferential tariff to incentivise reclaimed water over freshwater. The NUSP 2008[126], recommends reuse of wastewater in every city. The discharge standards as shown in Table 47Table 47 below at the Central level and State level have recently been revised (November 24, 2015) by CPCB for discharge in water bodies and on land. This also entails that reuse applications (in urban areas mainly for flushing and irrigation purposes and in rural areas for agriculture) can be followed keeping the health and safety perspective in mind.

Table 47: Discharge Standards (in water bodies and on land), 2015

For new STPs	Parameters	Standards*
	pH	6.5-9.0
	BOD	10
	COD	50
	TSS	20
	NH4-N	5
	N-Total	10
	Faecal Coliform (MPN/100 mg/l)	<100

Note: all values are in mg/l

[125] *Government of India, Ministry of Water resources, National Water policy 2012, 6*
[126] *Government of India, Ministry of Urban Development, National Urban Sanitation Policy, 2008, 34*

To meet the growing demand for water, wastewater treatment and reuse is gaining ground. Adequate clear guidelines and frameworks for implementation of treatment and recycling projects and enforcement of standards need to be developed. Detailed guidance has formally been included for the first time in the recently revised and updated Manual[127] on Sewerage and Sewage Treatment Systems (CPHEEO, Part A - Chapter 7 and Part C-Chapter 2, 2013). These guidelines take a lead in specifying, for the first time, the water quality guidelines for treated water based on its intended use. In Karnataka, through a Memorandum dated November 16, 2007, the Karnataka State Pollution Control Board, defined standards for urban reuse as shown in Table 48Table 48 below. These standards help in selecting appropriate technology and also in enforcement.

Table 48: Quality of treated sewage for urban reuse

No.	Parameter	Standard
1	pH	6-9
2	BOD_5, mg/l	≤ 10
3	Turbidity, NTU	≤ 2
4	E.Coli	None
5	Res. Cl_2, mg/l	≥1

At a national level, the next step would be to develop a national reuse policy that defines the legislation, regulation and financial requirements to make this a viable sector encouraging implementation for more treatment and reuse facilities in the country. Standards like those in Karnataka need to be defined, keeping in mind the revised discharge standards and also the capacity of the sector to implement such systems as well as the applicability of these standards.

7.1.2 Health Legislation and Considerations

The potential health risks of water reuse of any stakeholder exposed to the water or a product produced with it, depends on one hand, on the degree of exposure, and on the other hand on the adequacy, effectiveness and reliability of the treatment processes adopted. Non-potable use of treated wastewater is a common practice in many countries, and usually takes place under strict regulatory framework like in the USA (USEPA, 2012), Australia (Australian Guidelines for Water Recycling: Managing Health and Environmental Risks, 2008) or follows international standards like WHO, 2006. The goal of wastewater treatment is to prevent pollution and protect public and environmental health. The same goal is applicable to reuse of treated wastewater.

[127] *CPHEEO, Ministry of Urban Development, Manual on Sewerage and Sewage treatment systems, www.cpheeo.nic.in*

Water stress situations in towns and cities is a factor responsible for wastewater reuse with or without adequate treatment. This has a direct adverse impact on public health. Internationally, a multi-barrier approach is being adopted for wastewater reuse in agriculture to minimise risks and allow greater flexibility in reuse, subject to the type of crop being irrigated with treated, partially treated or untreated wastewater considering viral, bacterial and protozoan pathogens and helminth eggs (WHO, 2006). The Sanitation Safety Planning[128] (WHO, 2015) tool is also aimed at risk based management of exposure to human waste and can maximise health benefits. Quality standards for specific reuse applications and for agents that cause health hazards will enable defining of guidelines for ensuring safe treatment and reuse of wastewater.

In India, at the policy level, the NUSP 2008 highlights the health outcomes of improved sanitation. The Manual on Sewerage and Sewage Treatment Systems (CPHEEO, 2013) also highlights the public health outcomes of legislations related to wastewater treatment and reuse. Legislations linked to health in relation to wastewater are associated with Drinking Water Standards and Disposal and Reuse Standards (PCB standards). These standards (as highlighted in section 7.1.1 of this report) regulate the implementation and performance of the treatment systems ensuring that the environment or public health is not adversely affected by disposal or reuse of wastewater treatment and its reuse. The Environmental Health and Safety standards, including Occupational Health and Safety Standards for people working at sewage/effluent treatment facilities, is not explicitly dealt with other than in industrial set ups under the Factories Act, 1948 and in the ISO certification process for ensuring environmentally safe work conditions. However, for decentralised small scale systems, occupational health and safety has not been given emphasis. Operation and Maintenance of these systems is not considered as a hazardous service offering, even though the possibilities of exposure to hazardous events is present. The Public Liability Insurance Act, 1991, Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993 and Prohibition of Employment as Manual Scavengers and Their Rehabilitation Act, 2013 may be considered while ensuring that operation and maintenance of wastewater treatment systems are carried out legally. Additionally, inadequate or inappropriate collection and treatment of wastewater creates an unclean environment in the public domain and this can be termed as public nuisance, which is a punishable offence under the local Municipalities Act.

Monitoring and implementation of standards is a challenge and the inability to control wastewater reuse without meeting the health standards or without practicing risk mitigation measures can increase health risks significantly. While the benefits of wastewater recycle and reuse may be known to all stakeholders, there are operational obstacles faced by city governments and water utilities owing to the overlapping remits of institutions mandated to manage water in its different uses. This would need to be addressed through coordinated efforts at the national, state and city levels of administration.

[128] *WHO, 2015*

7.1.3 Economic Legislation and Considerations

India's investment in sanitation is increasing though it is still an extremely small component of the Union Budget. Private sector participation is being encouraged in the sector through various government schemes. Legislation is related to taxation, incentives, sales, export and investment. Central laws are applicable throughout the country though states can modify certain aspects.

Incentives for the water sector are available, though are very limited for the wastewater sector. Current Government schemes like the Namami Gange (www.nmcg.nic.in), Atal Mission for Rejuvenation and Urban Transformation (AMRUT - http://amrut.gov.in/), Smart Cities Mission (http://smartcities.gov.in/) and Swachh Bharat Mission have allocated funds as capital investment for implementing wastewater treatment. These programmes also encourage convergence between programmes so that the cities/towns can benefit from the funds available.

Private sector participation in this sector has been limited though the potential is growing. Appropriate models, especially for the reuse market, will encourage private sector participation and a formal market setup, especially for capital investment need to be developed.

The Manual on Sewerage and Sewage Treatment Systems (CPHEEO, 2013) recommends urban local bodies to be responsible for sanitation planning and financing public infrastructure and leveraging private investments. Resource mobilisation through tariff structures, inter-governmental fiscal transfers and targeting of subsidies, recovery of O&M cost through the introduction of usage charges and collection of dues has been highlighted as a means of ensuring accountability as well as financial sustainability.

The current fiscal incentives are linked to legislations associated with investment directives, import export laws, income tax laws and fund allocation of various government programmes and schemes. Foreign Direct Investment (FDI) is possible for water recycling systems. Loans for approved technologies can also be availed from nationalised banks and financial institutions. The Ministry of Micro, Small and Medium enterprises (MSME) and the National Innovation Council[129] has announced the launch of the India Inclusive Innovation Fund, designed to invest in several socially-relevant sectors including water and sanitation. Not for profit companies operating in wastewater treatment with the aim of environment conservation and preservation can also get a 100% income tax break from profits and gains. Tax and duties relief is also possible for import of materials linked to wastewater treatment/environmental protection. Subsidies are available for setting up on-site sanitation and treated wastewater conveyance pipelines.

[129] *Innovationcouncilarchive.nic.in*

7.1.4 Conclusions

The legislations discussed in the preceding section of the report encourage investment in the wastewater treatment and reuse sector as well as increased implementation of wastewater treatment facilities. Some regulations, however, might need to be reassessed to ensure that they don't discourage incremental steps towards improved wastewater management and reuse applications. For launching innovative interventions in this sector, approaches need to be coordinated and connected, right from clear sound policy guidelines to legislation and institutional arrangements. Government initiatives to develop implementation models with participation from private sector would be a step in the right direction.

Wastewater treatment technologies that can provide solutions that match the requirements of consent guidelines of Pollution Control Boards in different States of India, that can be located in space constraint situations (existing apartments, housing layouts, basement of buildings) and that meet the discharge and reuse standards would have a potential in the current wastewater market in India. Financial support and incentives would be available if the technologies can be certified as innovations, or if they fulfil the requirements of current Government schemes and also explicitly provide environmental benefits.

7.2 Turkey

On the road to membership in the European Union (EU), Turkey has been going through a dynamic process of legal reforms in the recent years[130]. Turkey assumes some responsibilities to introduce a series of fundamental reforms during the EU accession process. Approximation of national law and EU law contained in the acquis communautaire is one of the fundamental prerequisites of membership of the EU[131].

Owing to its efforts for the full membership of the EU, Turkey announced the "New EU strategy of Turkey" in September 2014, which consists of three pillars:

(i) Political Reforms
(ii) Socio-economic Transformation
(iii) The EU Communication Strategy

On the basis of the New EU strategy of Turkey "National Action Plan for the Accession to EU" has been prepared. The Action Plan is the roadmap which puts forward the steps to be taken

[130] *Küçükgüngör M.A., 2014. Harmonisation of Turkish law with the European Union legislation in the area of financial markets infrastructure: the new Capital Markets Law Unif. Law Rev. (2014) 19 (1): 88-105*

[131] *Turkish Ministry of Foreign Affairs Web Site: http://www.mfa.gov.tr/relations-with-the-european-union-in-the-field-of-environment.en.mfa, Date of Access: August 2016.*

and the priorities to be adopted in order to sustain and strengthen the political reforms in Turkey. In addition, it sheds light on the on-going socio-economic transformation. The first phase[132] of the Action Plan was carried out during November 2014-June 2015 period. The second phase[133] concerning the work to be carried out during June 2015-June 2019 includes primary legislation, secondary legislation, institution building and other relevant work for aligning with the EU legislation.

In Turkey, a variety of regulations have been adopted and still being with the aim of harmonising with the EU Acquis. In other words, legislation is constantly reviewing/changing in Turkey. Therefore, Turkish environmental, health and economy related legislations on domestic wastewater treatment and reuse, which is the major focus of INNOQUA project, need to be analysed by taking associated European environmental rules and regulations into account.

7.2.1 Environmental Legislation and Considerations

Turkey faces significant problems with water scarcity and the lack of adequate treatment of wastewater which become an issue of national importance lately. In recent years untreated domestic wastewater has polluted reservoirs and other surface fresh water sources that even large urban populations, such as Istanbul, rely upon[134]. Turkey's 10th Development Plan (2014-2018) outlines a series of challenges in protecting the country's water resources; these include (i) institutional shortcomings, (ii) fragmented legal frameworks for water resources management, (iii) lack of a common data collection system and (iv) inadequate monitoring systems. These developments are the major rationales of legislative framework of Turkey, which puts particular emphasis on the conservation of surface and groundwater resources.

Throughout the current EU harmonisation process of Turkey, one of the major EU legislations, pending to be harmonised is the Water Framework Directive. Turkey has now been in the process of adoption of a new "Water Law" (a draft was issued in 2016) with an aim of simplifying and streamlining existing legislation as well as harmonising with the European water legislation, the Water Framework Directive in particular. Since Turkey is not yet harmonised the EU Water Framework Directive (WFD) and not adopted the Water Law both legislations are excluded from this study. Apart from those two legislative efforts underway, some of the major legislative developments and regulations, which are relevant in terms of the treatment and reuse of domestic wastewater, are discussed below:

EU Environmental Harmonisation Strategy (2007-2023)

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[132] Turkish Ministry for EU Affairs Web Site: http://www.ab.gov.tr/files/napisonwebeng.pdf, Date of Access: September 2016.
[133] Turkish Ministry for EU Affairs Web Site: http://www.ab.gov.tr/files/pub/nap-ii-en.pdf, Date of Access: September 2016.
[134] International Trade Administration, 2016. Top Markets Report Environmental Technologies Country Case Study: Turkey U.S. Department of Commerce

The document of National Environmental Harmonisation Strategy comprises detailed information about technical and institutional infrastructure and the obligatory environmental improvements and regulations required for Turkey to adopt the EU environmental legal acquis. This is a precondition of entrance to EU, and to provide complete harmonisation for implementing the legislation effectively. In order to form an infrastructure for this, in the Strategy, the present situation about environmental problems of Turkey, legislation and institutional structure, policy followed up to today against environmental problems, investments made and the difficulties encountered in struggle against environmental problems are determined[135]. Moreover, the environmental fields to which priority is given in Turkey and the aims, targets, strategies and activities related to these are determined. While substantial progress has been made in implementation of environmental rules, the European Commission notes that additional national legislation is needed.

Environment Law (11.08.1983, No: 18132)

It is widely accepted that in Turkey the first concrete governmental action related to the qualitative assessment of water resources is The Environment Law adopted in 1983. The purpose of this law is to *"make provision for the improvement of use of land and natural resources and preserving the country's vegetative and livestock assets and natural and historical richness to protect and improve the environmental quality"*[136]. Environmental law is overseen by the Ministry of Environment and Urbanisation. The first article of the law specifies its purpose as being not only the prevention and elimination of pollution but also the preservation and utilisation of natural resources in the most appropriate manner.

Regulation on Water Pollution Control (31.12.2004, No: 25687)

The Water Pollution Control Regulation came into effect in 2004. The primary objective of the regulation is to establish the legal framework for water pollution control in order to preserve the potential of the country's water resources including groundwater and surface waters[137]. Moreover the regulation aims the best possible utilisation of resources as well as the prevention of water pollution in conformity with economic and social objectives.

In this regulation, below fundamental approaches are followed for sustainable water resource management[138]:

- Controlling and regulating the wastewater discharge practices

[135] *Technology Development Foundation of Turkey (TTGV), 2010. Identification of Framework Conditions and R&D Requirements for Dissemination of Cleaner Production Practices in Turkey*

[136] *Alhan C.M.K, 2015. Water management in Turkey and in Istanbul Presentation in Barcelona, Spain, February 20, 2015.*

[137] *Turkish Ministry of Forestry and Water Affairs, 2014. The legal and institutional water management in Turkey*

[138] *Alhan C.M.K, 2015. Water management in Turkey and in Istanbul Presentation in Barcelona, Spain, February 20, 2015.*

- Rehabilitation of water resources within the framework of an ecosystem and conservation of them in their existing conditions
- Protection and improvement of water quality in accordance with the requirements of the country
- Protection of drinking water supply reservoirs through buffer zones and land use restrictions

The Urban Wastewater Treatment Regulation (08.01.2006, No: 26047)

It has been set out to protect the environment against the adverse effects of urban wastewater collection, treatment and discharge as well as the wastewater discharge from certain sectors. The scope of the regulation consists of technical and administrative facts including:

- The collection of certain urban and industrial wastewaters discharged into the sewage system
- Treatment and discharge of urban wastewater
- Reporting and monitoring

Communiqué on Wastewater Treatment Plant Technical Procedures (20.03.2010, No: 27527)

The "Communiqué of Technical Methods" was revised by the Ministry of Environment and Urbanisation in 2010[139]. The Communiqué also includes wastewater reuse arrangements for irrigation purposes. This communiqué has been prepared in order to regulate the technical methods and implementations of;

- Wastewater treatment operations' design criteria
- Selection of technology wastewater treatment plants
- Reuse applications
- Disinfection of treated wastewaters
- Sludge disposal methods
- Deep sea discharge practices

Other Legislations on Water and Wastewater Management

Although of secondary importance, other regulations concerning the water and wastewater management, which might be relevant to INNOQUA project activities, can be listed as:

- Circular of wastewater treatment / deep sea discharge project approval (04.03.2014)
- Regulation on environmental permit and licence (10.09.2014, No: 29115)

[139] *Sudan, K., 2011. Wastewater management in Turkey: Present and Future Perspectives, Statistical, Economic and Social Research and Training Centre for Islamic Countries Higher Council for Environment and Natural Resources "Water Resources Management" 23rd-24th November, 2011.*

- Regulation on the protection of river basins and preparation of management plans (30.06.2009, No: 27274)
- Regulation on the management of surface water quality (30.11.2012, No: 28483)
- Regulation on the protection of groundwaters against pollution and degeneration (07.04.2012, No: 28257)
- Regulation on the monitoring of groundwaters and surface waters (11.02.2014, No: 28910)
- The Regulation on the Control of Pollution Caused by Hazardous Substances in Water Bodies and Environs (26.11.2005, No: 26005)
- The Regulation on the Environmental Impact Assessment (25.11.2014, No: 29186)
- Regulation on the auditing of water structures (12.05.2015, No: 29353)

Assessment of the Legislations from the Perspective of INNOQUA Project

Although it is still open to discussions, the outlet of the INNOQUA system to be applied in Sinop (Turkey) is envisioned to be reused as irrigation water, unless it is not diverted to the septic tank. Therefore, following legislations have to be evaluated depending on the technical features (e.g. configurations, treatment efficiencies) and expected effluent characteristics of INNOQUA system:

- Regulation on Water Pollution Control (31.12.2004 No: 25687)
- Communique on Wastewater Treatment Plant Technical Procedures (20.03.2010 No: 27527)
- Circular of Wastewater Treatment / Deep Sea Discharge Project Approval (04.03.2014)
- Regulation on Environmental Permit and Licence (10.09.2014 No: 29115)"

According to the Article 32 of the Regulation on Water Pollution Control (31.12.2004 No: 25687) no discharge consent is required currently. Because the population of the site in Sinop is expected to be under 84 person equivalent. So the domestic wastewaters (if not to be treated) need to be collected in leak proof septic tanks which are to be constructed in accordance with the “Regulations on Wells to be Constructed at Locations not feasible for a Sewer System” and transported to a wastewater treatment plant. According to the regulation, septic tanks are similar to holding tanks and all the contents of the septic tanks need to be transported to a wastewater treatment plant (WWTP).

As stated above, currently no treatment or discharge consent is required since the population of the site is going to be under 84 person equivalent. However, voluntary implementation of the INNOQUA system and subsequent water reuse practice will require several legislations (listed above) to be complied.

According to the Article 28 of the Regulation on Water Pollution Control (31.12.2004 Official Gazette No: 25687) the wastewaters, which are treated so as to comply with the quality criteria for the irrigation water specified in the “Communique on Wastewater Treatment Plant Technical Procedures” of the Regulation on Water Pollution Control, are encouraged to be used as irrigation water. The pre-treatment operations and necessary monitoring shall be carried out in accordance with the "Communique on Wastewater Treatment Plant Technical Procedures". Whether the wastewater is in compliance with such purposes shall be determined by a commission to be composed of representatives of the governorate General Directorate of Environment and Urbanisation, provincial Agriculture Directorate and Regional Directorate of Forestry and Water Affairs.

The major purpose of the INNOQUA system is to supply irrigation water for shrubbery/nursery ground. In other words irrigation requirements on the related legislations must be complied. Major legislation regarding the use of treated wastewater on irrigation is "the Communique on Wastewater Treatment Plant Technical Procedures (20.03.2010 No: 27527)". In this regulation, Annex 7, Table E7.1 describes the technical requirements of the treated water (Class B) to be used for irrigation purposes.

According to Annex 7, Table E7.1, Class B standards have to be met for treated domestic wastewaters to be reused for irrigation of “the plants which are not intended to be consumed as food”. According to the table, secondary treatment followed by disinfection by chlorination have to be applied. Secondary treatment may involve following: activated sludge systems, biodiscs, trickling filters, stabilisation ponds, aerated lagoons etc. In addition to the chlorination, which is a mandatory method, disinfection may involve other additional methods as well. Quality criteria for Class B wastewater to be reused for irrigation purposes is presented in Table 49 below:

Table 49: Quality criteria for Class B wastewater to be reused for irrigation of “the plants which are not intended to be consumed as food”

Criteria	**Value**
Suspended solids (mg SS/Litre)	30
pH	6–9
BOD_5 concentration (g BOD_5/Litre)	< 30
Faecal Coliforms[a]	< 200 col/100 mL
Free Chlorine	> 1 mg/L

a: Some other pathogen analyses may be required on need basis

Details (including frequency/type/reporting body) of compliance monitoring/sampling is presented in Regulation on Water Pollution Control (31.12.2004 No: 25687) and Communique on Wastewater Treatment Plant Technical Procedures (20.03.2010 No: 27527).

7.2.2 Health Legislation and Considerations

In Turkey, the Ministry of Health was responsible for environmental matters in general prior to the establishment of the Ministry of Environment. Due to its role and responsibilities about public health, The Ministry of Health plays an important role in certain aspects of environmental related health legislation. Regarding the water and wastewater associated health legislations the Ministry of Health has particular responsibilities for (i) bathing water and (ii) drinking water quality[140].

Bathing Water Directive (09.01.2006, No: 26048)

The EU Bathing Water Directive concerning the quality of bathing water was adopted by Turkey in 2006, when a bylaw provided a ten-year period for guide values for total and fecal coliform to be achieved. The bylaw defined the responsibilities of the ministries of health and of environment and urbanisation for monitoring and inspecting bathing areas[141].

The Ministry of Health - the Public Health Institution of Turkey works on the further harmonisation of the EU bathing water Directive 2006/7/EC and the draft by-law into the Turkish National Legislation. In addition within the framework of the Directive the bathing water quality monitoring system of Ministry of Health - Public Health Institution of Turkey is aimed to be strengthened. The draft “By-law on bathing water quality management” has been prepared with the transposition of 2006/7/EC EU Directive by the Ministry of Health, Public Health Institution of Turkey with the contribution of the relevant institutions.

Current and planned activities of The Ministry of Health and the Public Health Institution of Turkey on Bathing Water Directive include[142]:

- working on the draft by-law on bathing water quality management, transition from 76/160/EEC to 2006/7/EC Directive regarding the classification and quality assessment of bathing water,
- the pilot applications,
- establishing experimental bathing water profiles in the selected areas of the pilot provinces,
- compiling of sets of bathing water quality data,

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[140] Burak, S., 2007. Water and wastewater management in Turkey, The Istanbul case study on rapidly growing urban areas comprising illegal urbanisation in water catchment areas. Istanbul University-Institute of Marine Sciences and Management

[141] Delegation of the European Union to Turkey Web Site: http://avrupa.info.tr/eu-projects-at-a-glance/environment-transport-energy/monitoring-bathing-water.html Date of Access: September, 2016.

[142] Dilek, D., and Irmak, H., 2015. Alignment of New Bathing Water EU Directive and Its Applications to Protect Public Health
Public Health Institution of Turkey,
http://www.journalagent.com/z4/vi.asp?pdir=turkhijyen&plng=tur&un=THDBD-97059, Date of Access: October, 2016

- disseminating the results of pilot applications to the whole bathing areas,
- improvement of the bathing water quality monitoring system of the Ministry of Health in the direction of 2006/7/EC.

The Quality of Surface Water Intended for the Abstraction of Drinking Water Regulation (17.02.2005 No: 25730)

This regulation covers the rules about the surface waters intended for the abstraction of drinking water. Within the scope of the regulation, the principles, quality criteria and necessary treatment types are regulated[143]. The major aim is to provide the technical and hygienic conditions and ensure the quality standards of the waters for human consumption. Moreover the production, packaging, labelling, marketing and auditing procedures of the spring and drinking waters are also covered[144].

According to the regulation, if the water is polluted due to the parameters not included in the law and if the nature of this pollution poses a potential threat to human health, a separate monitoring is carried out for the substances and microorganisms, and necessary measures are taken[145].

7.2.3 Economic Legislation and Considerations

In this section, legislation on economic and financial instruments, which supports the investment of domestic wastewater treatment and reuse facilities, are discussed.

Decree on the Investment Incentives Regime (19.06.2012, No: 28328)

The Investment Incentive Regulation has come into force by the Cabinet Decision No: 2012/330. The purpose of this Decision is to promote value added investments, increase production and employment, enable the continuity of investment trends as well as to enable sustainable development, encourage large scale investments with a high content of technology, R&D that improves international competitiveness. It also aims to promote international investments, eliminate regional development differences and support investments of environmental protection as well as R&D.

The investment incentive system includes “four different investment schemes”. These are[146];

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[143] *Turkish Ministry of Forestry and Water Affairs, 2014. The legal and institutional water management in Turkey*

[144] *Turkish Ministry of Forestry and Water Affairs, 2014. The legal and institutional water management in Turkey*

[145] *The Republic of Turkey, 2006. Agenda item: quality of water Intended for human consumption Directive 98/83/EC*
Screening Chapter 27: Environment, Country Session: The Republic of Turkey 29 May - 02 June 2006

[146] *KPMG, 2012. The New Investment Incentives in Turkey, https://www.kpmg.com/TR/en/.../The-New-Investment-Incentives-in-Turkey.pdf Date of Access: October 2016.*

(i) General Investment Incentive Scheme
(ii) Regional Investment Incentive Scheme
(iii) Large Scale Investment Incentive Scheme
(iv) Strategic Investment Incentive Scheme

There are four different support schemes under the regime. The incentive tools generally include; tax and customs duty exemptions, social security premium supports, interest support and free land allocation.

Instrument for Pre-Accession Assistance (IPA) Environment Operational Programme

Instrument for Pre-Accession Assistance (IPA) mechanism has been developed in order to make use of the financial assistance during Turkey's pre-accession process to the EU and is the main financial instrument for providing EU support in implementing reforms to move towards EU membership[147].

One of the operational programme under the IPA scheme, Environmental Operational Programme, managed by the Turkish Ministry of Environment and Urbanisation aims to improve environmental protection and living standards for the public by supporting investments in the environment infrastructure sector in accordance with EU standards[148]. The programme objectives are to support the improvement of environment, specifically via investments in the area of water management cycle (both drinking and wastewater collection and treatment) and Solid Waste Management[149].

Other Finance and Investment Opportunities

Some of the other financial instruments and investment opportunities which can be used for the treatment and reuse facilities of domestic wastewater are discussed below[150]:

- *Financial instruments provided by international financial institutions:* External departments to Local Authorities are provided by international financial sources such as World Bank, the European Investment Bank (EIB), International Finance Corporation (IFC) and the German Investment and Development Bank (KfW).
- *General Budget of the Central Administration:* Public tender processes are employed for the wastewater treatment projects to be financed by the General Budget and mandated / granted to the private sector.

[147] *European Commission, 2014. Instrument for Pre-Accession Assistance (IPA II) Indicative strategy paper for Turkey (2014 -2020)*
[148] *Business Monitor International, 2014. Turkey Water Report Q1 2015 Part of BMI's Industry Report & Forecasts Series*
[149] *European Commission Web Site: http://ec.europa.eu/regional_policy/en/funding/ipa/turkey/ Date of Access: October 2016.*
[150] *Switzerland Global Enterprise, 2013. Market Report: Waste management report of Turkey, Green Consult and Finance Commercial Office Turkey,*

- *Budget of Local Authorities*: Budget of Local Authorities refers to the financing source directly provided by local governmental-administrative institutions such as equity financing by municipalities or bank loans provided by bank A.S with more favourable terms and conditions, as compared to commercial banks.
- *National/International grant-type R&D funding programs:* National grant-type and credit loan-type funding programs provided by existing national funding providers such as TTGV, KOSGEB, regional development agencies etc. are designed and applied for the financial support of Turkish companies' R&D and/or business activities and initiatives. In addition, international grant-type funding programs are available for Turkish companies if they form an international R&D cooperation with at least one foreign partner.

7.2.4 Conclusions

In Turkey's environmental policy, institutional and regulative reforms were realised in the 1980s in water pollution control area which is a direct result of Stockholm Conference (1972). Furthermore Turkey's membership in a number of international regimes and its efforts towards European Union (EU) accession in particular has given impetus to combating water pollution and further the protection of its natural resources by harmonising some of the existing EU regulations. Still, it is considered that Turkey lacks a comprehensive water legislation (e.g. water law) that would equally cover and balance the development and the protection of water resources[151].

In Turkey, a variety of regulations have been adopted and still being with the aim of harmonising with the EU Acquis. In other words, legislation is constantly reviewing/changing in Turkey. Therefore, Turkish environmental, health and economy related legislations on domestic wastewater treatment and reuse, which is the major focus of INNOQUA project, need to be analysed by taking associated European environmental rules and regulations into account.

Although it is still open to discussions, the outlet of the INNOQUA system to be applied in Sinop (Turkey) is envisioned to be reused as irrigation water, unless it is not diverted to the septic tank. Therefore, following legislations have to be evaluated depending on the technical features (e.g. configurations, treatment efficiencies) and expected effluent characteristics of INNOQUA system:

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- Communique on Wastewater Treatment Plant Technical Procedures (20.03.2010 No: 27527)
- Circular of Wastewater Treatment / Deep Sea Discharge Project Approval (04.03.2014)

[151] *Kibaroglu, A., Scheumann, W. and Kramer, A. eds., 2011. Turkey's Water Policy: National Frameworks and International Cooperation. Springer Science & Business Media.*

- Regulation on Environmental Permit and Licence (10.09.2014 No: 29115)"

This initial study should be taken as the “first screening step” for the analyses of the regulatory framework which might be relevant to the INNOQUA project pilot applications in Sinop, Turkey. Therefore more detailed analyses need to be conducted on each of the legislations covered in this study.

8 Conclusions

The health and environmental implications associated with exposure to insufficiently treated wastewaters are well documented by organisations such as the World Health Organisation and the United Nations Environment Program. However, the implementation and enforcement of suitable regulations are often highly specific to each region, country or even locality.

In some instances, this can allow for the implementation of locality specific regulations that are in-tune with specific environmental agendas and prevent enforcement of regulations that are either not relevant or are not seen as a priority for the given location.

On the other hand, in some regions insufficient regulations are in place to ensure sufficient provisions of suitable sanitation and access to clean water. There are many reasons for this which are detailed in this report, such as political and economic situations and constraints. In such regions environmental issues may only be addressed with reactive rather than preventative measures.

The INNOQUA technologies will be piloted in a range of geographic locations around the world, under a range of conditions. Whether this is within a region with a highly developed sanitation infrastructure, or a region with very limited sanitation regulation, the technologies will need to comply with all relevant environmental, health and building regulations outlined in this report. Additionally, the technologies should meet the minimum water quality guidelines set out by the WHO to ensure that the technologies promote safe standards for sanitation and water re-use.

A summary of the key pieces of legislation and considerations identified for each region in this report can will be submitted into deliverable 1.2 and 2.1 report.

9 Annex

9.1 Tanzania

9.1.1 Annex 1

Factors	Laws and Regulations	Implementation Mandate
Environmental Factors **Notes:** Waste Water Treatment Projects fall under Type A projects which require full Environmental Impact Assessment. This is done by a registered Environmental Engineer. All processes are regulated by NEMC. This applies to any public sanitation facility (excluding household) regardless of the size. Commercial installations are treated as public projects Basin Water Boards issue and monitors discharge permits for industrial and Municipal effluent.	Environmental Management Act, 2004	✓ Establishes Institutional set-up for environmental Management ✓ Makes provisions for coordination among the sectors ✓ Gives mandate to National Environmental Management Council (NEMC) for compliance and Law enforcement ✓ Empowers Local Government Authorities for environmental protection. ✓ Stipulates penalties for non-compliance
	Environmental Impact Assessment and Audit Regulations, 2005	✓ Creates requirement for projects to undertake Environmental Impact Assessments ✓ Classifies project between mandatory and those that only preliminary assessment
	Environmental Management Water Quality Standards Regulations, 2007	✓ Sets quality standards and discharge limits for municipal and industrial effluent
	Water Resources Management Act, 2009	✓ Creates the Basin Water Boards (BWB) to oversee Water Resources Management ✓ Give Mandate to BWB to issue waste water discharge permits to industries and other institutions ✓ Mandates BWB to monitor Waste Water discharge standards

Any discharge to water bodies is regulated by the Basin Water Boards		
Health Factors **Notes:** The Ministry of Health and Social Welfare oversees all the public health aspects relating to sanitation. The Directorate of Preventive Health Services, gives clearance for sanitation technology and forwards recommendation letter to respective units. Health Officers are responsible for monitoring sanitation at household level. By-laws are used.	Public Health Act,	The Act gives mandate to the Local Government Authority to oversee: ✓ Land allocation for construction of public sanitation facilities. ✓ Manage disposal Areas. ✓ Collect, transport and dispose solid and liquid waste. ✓ Make by-laws. ✓ Check and approve building permits.
	National Sanitation Guidelines National Sanitation options and Construction guidelines School Water Sanitation and Hygiene Guidelines	✓ Provide overall guidance on the implementation of the National Sanitation Campaign. ✓ Sets Minimum standards for selection and construction of sanitation facilities in public places and at household level. ✓ Provide specific guidance for provision of water supply and sanitation facilities as well as hygiene education in public schools.
Service provision Regulation of sanitation services is different between Urban and Rural Context. In Urban Areas, WSSAs and Water	Water Supply and Sanitation Act	✓ Creates Water Supply and Sanitation Authorities (WSSA) and Water Utilities for urban areas ✓ Creates Community Water Supply Organisations (COWSOs) for water supply in the rural areas ✓ Creates and give regulatory mandate to Energy and Water Utilities Regulatory Authority ✓ Mandates LGAs to regulate COWSOs

Utilities are required to provide sanitation services. Sewer networks are managed by the WSSA and regulated by EWURA. In areas without sewer network both the LGA and Water Utilities are responsible for service provision. Any big investments in the WSSA needs approval of EWURA	EWURA Act, 2001	✓ Licences WSSA ✓ Regulates level of investments by the Water Supply and Sanitation Authorities ✓ Regulates planning and procurement of major projects ✓ Review and set rates for water supply and sewerage services ✓ Monitors waste water discharge standards

9.1.2 Annex 2

FIRST SCHEDULE

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(*Made under Regulation 8*)

PERMISSIBLE LIMITS FOR MUNICIPAL AND INDUSTRIAL EFFLUENTS

Table A: Physical Components

Parameter	**Limit**	**Test Method**
BOD5 at 20 oC	30 mg/l	TZS 861(Part 3):2006 – Five-day BOD Method
COD	60 mg/l	TZS 861(Part 4):2006 – Dichromate Digestion Method
Colour	300 TCU	ISO 7887: 1994, Water quality – Examination and determination of colour – Section 3: Determination of true colour using optical instruments
pH range	6.5-8.5	TZS 861(Part 2):2006 – Electrometric Method
Temperature range	20-35oC	See Annex 2
Total Suspended Solids (TSS)	100 mg/l	TZS 861(Part 1):2006 – Gravimetric Method
Turbidity	300 NTU	APHA Standard Methods:2130 B. Nephelometric Method

Table B: Inorganic Components

Parameter	**Limit (mg/l)**	**Test Method**
Aluminium (as Al)	2.0	TZS 861(Part 7):2006 – Direct Nitrous Oxide-Acetylene Flame Atomic Absorption Spectrometry
Arsenic (As)	0.2	TZS 861(Part 8):2006 – Manual hydride Generation- Atomic Absorption Spectrometry
Barium (Ba)	1.5	TZS 861(Part 7):2006 – Direct Nitrous Oxide-Acetylene Flame Atomic Absorption Spectrometry
Cadmium (Cd)	0.1	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry

Chromium (total)	1.0	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry
Chromium VI	0.1	TZS 861(Part 9):2006 – Colorimetric Method
Chlorides (Cl-)	200	APHA Standard Methods: 4110 B. Ion Chromatography with Chemical Suppression of Eluant Conductivity
Cobalt (Co)	1.0	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry
Copper (Cu)	2.0	TZS 861(Part 7):2006 - Flame Atomic Absorption Spectrometry
Fluorides (F-)	8	APHA Standard Methods: 4110 B. Ion Chromatography with Chemical Suppression of Eluant Conductivity
Iron	5.0	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry
Lead (Pb)	0.1	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry
Manganese	5.0	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry
Mercury (Hg)	0.005	TZS 861(Part 10):2006 – Cold-Vapor Atomic Absorption
Nickel (Ni)	0.5	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry
Nitrates (NO3-)	20	APHA Standard Methods: 4110 B. Ion Chromatography with Chemical Suppression of Eluant Conductivity
Phosphorus Total (as P)	6	TZS 861(Part 6):2006 – Colorimetric- Ascorbic Acid Method
Selenium (Se)	1.0	TZS 861(Part 8):2006 – Manual hydride Generation- Atomic Absorption Spectrometry
Silver (Ag)	0.1	ISO 15586: 2003, Water quality – Determination of trace elements using atomic absorption spectrometer with graphite furnace
Sulphate (SO 2-) 4	500	APHA Standard Methods: 4110 B. Ion Chromatography with Chemical Suppression of Eluant Conductivity
Sulphides (S-)	1	APHA Standard Methods: 4110 B. Ion Chromatography with Chemical Suppression of Eluant Conductivity
Tin (Sn)	2.0	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry

Total Kjeldahl Nitrogen (as N)	15	TZS 861(Part 5):2006 – Kjeldahl Method
Vanadium	1.0	ISO 15586: 2003, Water quality – Determination of trace elements using atomic absorption spectrometer with graphite furnace
Zinc (Zn)	5.0	TZS 861(Part 7):2006 – Flame Atomic Absorption Spectrometry

Table C: Organic Components

Parameter	**Limit (mg/l)**	**Test Method**
1, 1, 2 -Trichloroethane	0.06	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
1,1,1 - Trichloroethane	3.0	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
1,2 - Dichloroethylene	0 . 2	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
1,2 - Dichloroethane	0.04	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
1,3 - Dichloropropene	0.2	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
Alkyl benzene sulfonate (ABS)	0.5	ISO 7875 – 1: 1996, Determination of surfactants – Pat 1: Determination of anionic surfactants by measurement of the methylene blue index (MBAS)
Aromatic nitrogen containing compounds (e.g., aromatic amines)	0.001	APHA Standard Methods 6410: Liquid- liquid extraction GC/MS method

cis-1, 2 - Dichloroethylene	0.4	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)

Dichloromethane	0.2	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
Oil and Grease (fatty maters and hydrocarbons)	10	APHA Standard methods 5520
Organochlorine pesticides (Cl)	0.0005	GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas Chromatographic method after Liquid-Liquid extraction)
Other aromatic and/or aliphatic hydrocarbons not used as pesticides	0.05	GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas Chromatographic method after Liquid-Liquid extraction)
Pesticides other than organochlorines	0.01	GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas Chromatographic method after Liquid-Liquid extraction)
Phenols	0.002	GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas Chromatographic method after Liquid-Liquid extraction
Tetrachloroethylene	0.1	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
Tetrachloromethane	0.02	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)
Trichloroethylene	0.3	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.)

Table D: Microbiological Components		
Parameter	**Limit**	**Test Method**
Total Coliform Organisms	10,000counts /100mL	ISO 6222:1999, Microbiological methods